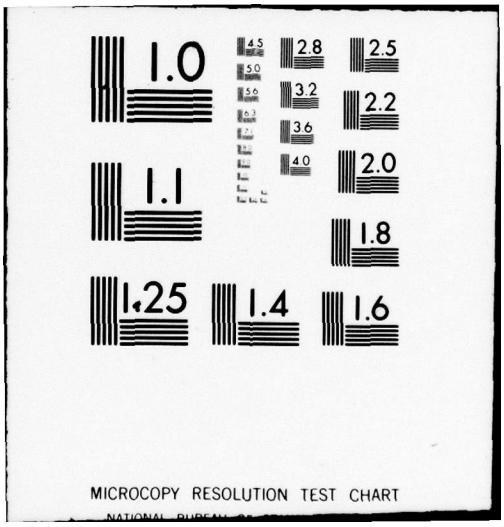
AD-A074 530 NEW JERSEY DEPT OF ENVIRONMENTAL PROTECTION TRENTON F/G 13/2
NATIONAL DAM SAFETY PROGRAM. EAST BRANCH RESERVOIR DAM (NJ 0037--ETC(U)
AUG 79 A G POSCH DACW61-79-C-0011

UNCLASSIFIED NL

| OF |
ADA
074530

END
DATE
FILMED
11 -79
DDC


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6
6.3
MICROCOPY RESOLUTION TEST CHART

B.S. 1

RARITAN RIVER BASIN
EAST BRANCH, SOMERSET COUNTY
NEW JERSEY

(15) DACW61-79-C-0011

LEVEL II

EAST BRANCH
RESERVOIR DAM
NJ 00373

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

East Branch Reservoir Dam (NJ 00373)
Raritan River Basin, East Branch,
Somerset County, New Jersey.
Phase 1 Inspection Report.

(9) Final rept.,

(12) 86 p.

(10) Anthony G. Posch

DEPARTMENT OF THE ARMY
Philadelphia District
Corps of Engineers
Philadelphia, Pennsylvania

(11) August 1979

410891D

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: NJ00373	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE *(and Subtitle)*: Phase I Inspection Report National Dam Safety Program East Branch Reservoir Dam Somerset County, N.J.	5. TYPE OF REPORT & PERIOD COVERED: FINAL
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): Posch, Anthony, G. P.E.	8. CONTRACT OR GRANT NUMBER(s): DACW61-79-C-0011 ✓
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Harris-ECI 453 Amboy Ave. Woodbridge, NJ 03301	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS: U.S. Army Engineer District, Philadelphia Custom House, 2d & Chestnut Streets Philadelphia, Pennsylvania 19106	12. REPORT DATE: August, 1979
	13. NUMBER OF PAGES: 60
14. MONITORING AGENCY NAME & ADDRESS *(if different from Controlling Office)*	15. SECURITY CLASS. *(of this report)*: Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT *(of this Report)*

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*

18. SUPPLEMENTARY NOTES

Copies are obtainable from National Technical Information Service, Springfield, Virginia, 22151.

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Dams
Spillways
Structural Analysis
Visual Inspection
National Dam Inspection Act Report
East Branch Reservoir Dam, N.J.

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

This report cites results of a technical investigation as to the dam's adequacy. The inspection and evaluation of the dam is as prescribed by the National Dam Inspection Act, Public Law 92-367. The technical investigation includes visual inspection, review of available design and construction records, and preliminary structural and hydraulic and hydrologic calculations, as applicable. An assessment of the dam's general condition is included in the report. ←

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
CUSTOM HOUSE—2 D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

IN REPLY REFER TO

NAPEN-D

Honorable Brendan T. Byrne
Governor of New Jersey
Trenton, NJ 08621

20 SEP 1979

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for East Branch Reservoir Dam in Somerset County, New Jersey which has been prepared under authorization of the Dam Inspection Act, Public Law 92-367. A brief assessment of the dam's condition is given in the front of the report.

Based on visual inspection, available records, calculations and past operational performance, East Branch Reservoir Dam, a high hazard potential structure, is judged to be in poor overall condition. The dam's spillway is considered inadequate since 21 percent of the Spillway Design Flood--SDF - would overtop the dam. (The SDF, in this instance, is one half of the Probable Maximum Flood). The decision to consider the spillway "inadequate" instead of "seriously inadequate" is based on the determination that dam failure from overtopping would not significantly increase the hazard to loss of life downstream from the dam from that which would exist just before overtopping failure. To insure adequacy of the structure, the following actions, as a minimum, are recommended:

a. The spillway's adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures, and studies within six months from the date of approval of this report. Any remedial measures necessary to insure the adequacy of the spillway and to prevent overtopping should be initiated within calendar year 1980. In the interim, a detailed emergency operation plan and warning system should be promptly developed. Also, during periods of unusually heavy precipitation, around the clock surveillance should be provided.

b. Within three months from the date of approval of this report, engineering studies and analyses should be performed to determine the dam's foundation condition, joint system geometry, seepage patterns and structural stability. Any remedial measures found necessary should be initiated within calendar year 1980.

c. The following remedial actions should be completed within six months from the date of approval of this report:

(1) Repair all areas of deteriorated concrete, and pressure grout the dam/rock interface where seepage is occurring and all foundation rock joints as determined by inspection.

(2) Restore access to the low-level outlet valve and repair the valve if necessary.

(3) Place mass concrete to fill the voids in the rock caused by mass-wasting.

(4) Dredge the sediment from the reservoir.

d. The following actions should be completed within one year from the date of approval of this report:

(1) The existing dam plans and drawings should be annotated and updated to form a coherent as-built set.

(2) A formalized program of annual inspections of the dam by an experienced party should be initiated, utilizing the standard visual check list in this report. A headwater gage should be installed in the dam, and read out during severe rain storms and at routine operating and maintenance and operating events of the dam and the lake. Movement of the dam should be monitored regularly by means of surveying monuments, and any change in seepage rates should be noted.

A copy of the report is being furnished to Mr. Dirk C. Hofman, New Jersey Department of Environmental Protection, the designated State Office contact for this program. Within five days of the date of this letter, a copy will also be sent to Congresswoman Millicent Fenwick of the Fifth District. Under the provision of the Freedom of Information Act, the inspection report will be subject to release by this office, upon request, five days after the date of this letter.

Additional copies of this report may be obtained from the National Technical Information Services (NTIS), Springfield, Virginia 22161 at a reasonable cost. Please allow four to six weeks from the date of this letter for NTIS to have copies of the report available.

NAPEN-D
Honorable Brendan T. Byrne

An important aspect of the Dam Safety Program will be the implementation of the recommendations made as a result of the inspection. We accordingly request that we be advised of proposed actions taken by the State to implement our recommendations.

Sincerely,

JAMES G. TON
Colonel, Corps of Engineers
for District Engineer

1 Incl
As stated

Copies furnished:
Dirk C. Hofman, P.E., Deputy Director
Division of Water Resources
N.J. Dept. of Environmental Protection
P.O. Box CN029
Trenton, NJ 08625

John O'Dowd, Acting Chief
Bureau of Flood Plain Management
Division of Water Resources
N.J. Dept. of Environmental Protection
P.O. Box CN029
Trenton, NJ 08625

EAST BRANCH RESERVOIR DAM (NJ00373)

CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 1 May 1979 by Frederic R. Harris Inc. under contract to the State of New Jersey. The State, under agreement with the U.S. Army Engineer District, Philadelphia, had this inspection performed in accordance with the National Dam Inspection Act, Public Law 92-367.

East Branch Reservoir Dam, a high hazard potential structure, is judged to be in poor overall condition. The dam's spillway is considered inadequate since 21 percent of the Spillway Design Flood--SDF - would overtop the dam. (The SDF, in this instance, is one half of the Probable Maximum Flood). The decision to consider the spillway "inadequate" instead of "seriously inadequate" is based on the determination that dam failure from overtopping would not significantly increase the hazard to loss of life downstream from the dam from that which would exist just before overtopping failure. To insure adequacy of the structure, the following actions, as a minimum, are recommended:

a. The spillway's adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures, and studies within six months from the date of approval of this report. Any remedial measures necessary to insure the adequacy of the spillway and to prevent overtopping should be initiated within calendar year 1980. In the interim, a detailed emergency operation plan and warning system should be promptly developed. Also, during periods of unusually heavy precipitation, around the clock surveillance should be provided.

b. Within three months from the date of approval of this report, engineering studies and analyses should be performed to determine the dam's foundation condition, joint system geometry, seepage patterns and structural stability. Any remedial measures found necessary should be initiated within calendar year 1980.

c. The following remedial actions should be completed within six months from the date of approval of this report:

(1) Repair all areas of deteriorated concrete, and pressure grout the dam/rock interface where seepage is occurring and all foundation rock joints as determined by inspection.

(2) Restore access to the low-level outlet valve and repair the valve if necessary.

(3) Place mass concrete to fill the voids in the rock caused by mass-wasting.

(4) Dredge the sediment from the reservoir.

d. The following actions should be completed within one year from the date of approval of this report:

(1) The existing dam plans and drawings should be annotated and updated to form a coherent as-built set.

(2) A formalized program of annual inspections of the dam by an experienced party should be initiated, utilizing the standard visual check list in this report. A headwater gage should be installed in the dam, and read out during severe rain storms and at routine operating and maintenance and operating events of the dam and the lake. Movement of the dam should be monitored regularly by means of surveying monuments, and any change in seepage rates should be noted.

APPROVED: Joel Tollerton LTC
JAMES G. TON
Colonel, Corps of Engineers
District Engineer

DATE: 19 September 1979

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam: East Branch Reservoir, I.D. NJ00373

State Located: New Jersey

County Located: Somerset County

Stream: East Branch

Date of Inspection: May 1, 1979

Assessment of General Condition

East Branch Reservoir Dam is a concrete gravity dam, approximately 142 feet long and 32.5 feet high, with a 63-foot wide spillway on the right side of the dam. The dam is in poor overall condition. Mass wasting of bedrock has taken place in the past, and large blocks have been displaced from 20 feet in front of the right abutment. The process appears to be continuing and the foundation stability will eventually be threatened unless remedial measures are taken. There is seepage at the interface of the dam and the rock abutments, also at the horizontal construction joints. Areas of concrete on both the upstream and downstream abutment faces have deteriorated severely. The concrete surface of the spillway is spalled and in areas, reinforcing steel is exposed. The low-level outlet is not presently operable. The hazard potential is rated as "high."

The safety of East Branch Reservoir Dam is considered questionable in view of its lack of spillway capacity to pass one half of the PMF without overtopping the dam. The spillway is capable of passing a flood equal to 10% of the PMF, and is assessed as "inadequate."

At present, the engineering data available is not sufficient to make a definitive statement on the stability of the dam.

The following actions, therefore, are recommended along with a time-table for their completion.

1. Conduct a detailed foundation stability study within three months, covering the joint system geometry.

2. Establish a flood warning system for the downstream communities within three months.

3. Carry out a more precise hydrologic and hydraulic analysis of the

dam within six months, to determine the need and type of mitigating measures necessary. If required, conduct a study of the means of increasing spillway discharge capacity and develop alternative schemes for construction. This should include the installation of headwater and tailwater gages.

4. Carry out remedial measures to the dam structure within six months, including repair of cracked and spalled concrete with epoxy cement. Restore the low-level outlet to an operable condition. Pressure grout all joints in the rock foundation, and repair the areas where mass-wasting has occurred by placing mass concrete in the voids.

Furthermore, while of a less urgent nature, the following additional action is recommended and should be carried out in the near future.

1. A program should be developed to monitor the seepage through the dam. Depending on the information provided, the need for corrective measures can be considered and, if necessary, undertaken.

2. Existing plans and drawings of the dam should be annotated and updated to form a coherent as-built set.

3. A program of annual inspection and maintenance should be initiated. This should include lowering the lake and updating the operation and maintenance log.

East Branch Reservoir is now used for recreational purposes only. If the recommended actions are not followed within the specified time, the possibility of removal of the dam should be considered.

Anthony G. Posch, P.E.

AGP/REJ/ak

East Branch Reservoir Dam
Overall view of dam from downstream.

May 1, 1979

TABLE OF CONTENTS

TABLE OF CONTENTS CONTINUED

PLATES

APPENDICES

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

EAST BRANCH RESERVOIR DAM, I.D. NJ00373

SECTION 1: PROJECT INFORMATION

1.1 General

a. Authority

The National Dam Inspection Act (Public Law 92-367, 1972) provides for the National Inventory and Inspection Program by the U.S. Army Corps of Engineers. This inspection was made in accordance with this authority under Contract C-FPM No. 35 with the State of New Jersey who, in turn is contracted to the Philadelphia District of the Corps of Engineers.

b. Purpose of Inspection

The visual inspection of East Branch Reservoir Dam was made on May 1, 1979. The purpose of the inspection was to make a general assessment as to the structural integrity and operational adequacy of the dam and its appurtenant structures.

c. Scope of Report

The report summarizes available pertinent data relating to the project; presents a summary of visual observations made during the field inspection; presents an evaluation of hydrologic and hydraulic conditions at the site; presents an evaluation as to the structural adequacy of the various project features; and assesses the general condition of the dam with respect to safety.

1.2 Description of Project

a. Description of Dam and Appurtenances

East Branch Reservoir Dam is a concrete dam, approximately 142 feet in length, having a 63 foot wide spillway on the right side of the dam. The spillway is a concrete triangular ungated overflow. There is a buttress giving lateral support to the left-hand wall. The original dam was a masonry rubble structure with a height of 17 feet. The present dam was built to cover the old structure, increasing the height to 32.5 feet. A geologic survey shows that the foundation is basaltic rock.

A small tunnel passes through the dam for access to the low-level

outlet valve.

b. Location

East Branch Reservoir Dam is located to the north of Bound Brook in the Township of Bridgewater, Somerset County, New Jersey. It is accessible by means of Chimney Rock Road.

c. Size and Hazard Classification

East Branch Reservoir Dam has a structural height of 32.5 feet and a reservoir storage of 163 acre-feet. Since its storage is less than 1,000 acre-feet and its height is less than 40 feet, it is classified in the dam size category as being "small." A hazard potential classification of "high" has been assigned to the dam on the basis that overtopping caused by the 1/2 PMF is likely to result in excessive property damage to the quarry, 1,000 feet downstream, and to the road bridge and restaurant 2,300 feet downstream. In this event, the possibility also exists of the loss of more than a few lives.

d. Ownership

East Branch Reservoir Dam is owned by:

Elizabethtown Water Company
1 Elizabeth Plaza
Elizabeth, New Jersey 07207
(201) 354-4444

Attention: Mr. Tom Cawley

e. Purpose

East Branch Reservoir Dam is presently used for recreational purposes only. It was originally used to supply water to Bound Brook.

f. Design and Construction History

The original dam was constructed in 1888 as a masonry structure. In 1905 the present concrete dam was constructed on top of the previous structure. Drawings prepared for construction are available from the Elizabethtown Water Company, but the design is not documented. The dam is not known to have been modified since 1905.

g. Normal Operational Procedures

The normal discharge from the lake is over the unregulated spillway and it is allowed to naturally balance with the inflow from

East Branch. The low-level outlet is not operable and the lake is therefore, not lowered on a regular basis.

1.3 Pertinent Data

a. Drainage Area:	10.5 square miles
b. Discharge at Dam Site	
Maximum known flood at dam site:	Elev. 148.3' (1971 flood) Phone conversation with Elizabethtown office.
Ungated spillway capacity at elevation of top of dam:	4,620 cfs (elev. 147.3')
Total spillway capacity at maximum pool elevation:	15,902 cfs (elev. 153.4')
c. Elevation (Feet above MSL)	
Top of dam:	147.3'
Maximum pool design surcharge (SDF):	153.4'
Recreation pool:	140.0'
Spillway crest:	140.0'
Streambed at centerline of dam:	115'
Maximum tailwater:	120' (estimate)
d. Reservoir	
Length of maximum pool:	1,800 feet ± (estimate)
Length of recreation pool:	1,000 feet ± (estimate)
e. Storage (Acre-feet)	
Design surcharge (SDF):	270
Top of dam:	163
Spillway crest:	77
f. Reservoir Surface (Acres)	
Maximum pool (SDF):	24 (estimate)

Top of dam:	16 (estimate)
Spillway crest:	9

g. Dam

Type:	Concrete Gravity
Length:	142'
Height:	32.5'
Top width:	2'
Side slopes - Upstream:	1H:1V
- Downstream:	Vertical
Cutoff:	None
Grout curtain:	None

h. Diversion and Regulating Tunnel

N/A

i. Spillway

Type:	Triangular concrete section. Ungated overflow.
Length of weir:	62.8'
Crest elevation:	140' MSL
Gates:	None
U/S Channel:	East Branch
D/S Channel:	Stepped rock down to Middle Brook.

j. Regulating Outlets

Low-level outlet:	20" diameter (inoperable)
Controls:	Unknown-inaccessible
Outlet:	10" ø water main (disused)

SECTION 2: ENGINEERING DATA

2.1 Design

Drawings of the dam were available in the files of the Elizabethtown Water Company. No hydraulic calculations for the spillway design were available, nor were stability calculations.

2.2 Construction

Construction history has been provided in Section 1.2.f. Engineering data relating to quality of concrete, means of construction, etc. are not on record.

2.3 Operation

No engineering data concerning the operation of the dam and reservoir are known to exist.

2.4 Evaluation

a. Availability

The availability of engineering data is poor. The only data available are some drawings illustrating the plan and profile views of the original and existing dams. The drawings can be obtained from the Elizabethtown Water Company.

b. Adequacy

The available engineering data is not sufficient to perform a comprehensive, definitive stability analysis of the structure. Data needed to fully assess the stability of the dam include:

1. Subsurface information at the damsite, including engineering properties of the rock and the joint system geometry.

2. The level of siltation.

3. Engineering properties of the old masonry dam.

4. Uplift forces on the base of the dam.

c. Validity

Information contained in the drawings was found by visual inspection to be valid, but details of the control valve for the low-level outlet were not given and could not be verified.

SECTION 3: VISUAL INSPECTION

3.1 Findings

a. General

The visual inspection made of East Branch Reservoir Dam revealed that it was in a detriorated state. Unless remedial measures are taken to maintain its serviceability, the possibility of removal of the dam should be considered.

b. Dam

The dam is in an advanced stated of deterioration due to freeze-thaw action. The upstream face of the left abutment wall is heavily spalled above the waterline. The downstream face of the abutment wall and the buttress are severly deteriorated, and areas up to 10 square feet are spalled to a depth of 4 inches, exposing reinforcing bars.

Poor horizontal construction joints were observed on the downstream face of the abutment wall and buttress, and reservoir water was seeping through. At the interface of the buttress slab and the abutment, seepage was estimated at approximately 10-15 gpm. Also seepage was observed at the structure to rock abutment on the right side.

The rock foundation of the dam was examined, and a process of masswasting of the rock below the dam was found to have occurred. This had progressed to approximately 20 feet from the base of the dam at the time of inspection. Chemical deterioration of the rock is negligable, but frost action has spalled large blocks away, particularly below the right abutment. Minor seepage through the joints was noted.

c. Appurtenant Structures

1. Spillway

The condition of the spillway is poor. The concrete surface is spalled, revealing reinforcing steel. The spillway, however, shows no signs of movement and is in good alignment.

2. Low-level Outlet

A 20 inch diameter low-level outlet is shown on the plans. This outlet is judged to be inoperable in case of an emergency, because the access to the control valve has been cut off due to a missing ladder in the tunnel.

d. Reservoir Area

The reservoir is situated in a steep "v" shaped valley with grass banks and trees. No buildings or dwellings are built on or near the shoreline. Considerable sedimentation was visible, but the depth could not be determined.

e. Downstream Channel

The downstream channel winds through a very steep rock gorge immediately downstream of the dam. There is a further drop approximately 15 to 20 feet downstream of the dam. No major obstruction or bends are in the channel. Downstream the channel runs adjacent to Route 525, and near to a quarry and a restaurant.

SECTION 4: OPERATIONAL PROCEDURES

4.1 Procedures

East Branch Reservoir Dam is used to impound water for recreation activities only. The lake level is maintained by unregulated discharge over the spillway, balancing the inflow.

The low-level outlet is inoperable and the impoundment, therefore, cannot be drained.

4.2 Maintenance of the Dam

There is no program of regular inspection and maintenance of the dam and appurtenant structures. Operation and maintenance is the responsibility of the Elizabethtown Water Company, owner of the dam. At present, no records of operation and maintenance are kept.

4.3 Maintenance of Operating Facilities

The low-level outlet gate valve is inoperable. No known maintenance of the valve has been made to keep the valve operable. The outlet pipe has not received maintenance.

4.4 Evaluation

The present operational and maintenance procedures are poor, and are not conducive to satisfactory operation of the dam.

SECTION 5: HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. Design

The drainage area above East Branch Reservoir Dam is approximately 10.5 square miles. A drainage map of the watershed of the dam site is presented on plate 1, Appendix D.

The topography within the basin is moderate to steeply sloped. Elevations range from approximately 550 feet above MSL at the north end of the watershed to about 140 feet at the dam site. Land use patterns within the watershed are mostly wooded and partly residential development.

The evaluation of the hydraulic and hydrologic features of the lake was based on criteria set forth in the Corps Guidelines and additional guidance provided by the Philadelphia District, Corps of Engineers. The SDF for the dam falls in a range of 1/2 PMF to PMF. In this case the low end of the range, 1/2 PMF, is chosen since the factors used to select size and hazard classification are on the low-side of their respective ranges.

The probable maximum flood (PMF) was calculated from the probable maximum precipatation using Hydrometeorological Report No. 33 with standard reduction factors. Due to the small drainage area, the SCS triangular hydrograph transformed into a curvilinear hydrograph was adopted for developing the unit hydrography, with the aid of the HEC1-DB Flood Hydrograph Computer program.

Initial and infiltration loss rates, were applied to the probable Maximum Precipitation to obtain rainfall excesses. The rainfall excesses were applied to the unit hydrograph to obtain the PMF and various ratios of PMF utilizing program HEC1-DB.

The SDF peak inflow calculated for East Branch Reservoir Dam is 15,902 cfs. This value is derived from the 1/2 PMF, and results in over-topping of the dam.

The stage-outflow relation for the spillway was determined utilizing HEC1-DB program from the known spillway length and elevation and the assumed discharge coefficient (see computer printout).

The reservoir stage-storage capacity relationship was computed directly by the conic method, utilizing the HEC1-DB program. The conic method assumes that the reservoir capacity resembles a series of vertically stacked cones. The reservoir surface areas at various elevations were measured by planimeters from U.S.G.S. Quadrangle topographic maps. Reservoir storage capacity included surcharge

levels exceeding the top of the dam, and the spillway rating curve was based on the assumption that the dam remains intact during routing.

A breach analysis indicates that the hazard potential for loss of life downstream, due to dam failure from overtopping, is not significantly greater than that which exists without failure.

Drawdown calculations indicate that if the 20 inch diameter low-level outlet were restored to working order, the reservoir could be lowered to an elevation of 119' MSL within a period of 88 hours, assuming a 2 cfs/square mile inflow. This is considered an adequate time-frame for drawdown and no additional outlet facilities are recommended.

b. Experience Data

No records of reservoir stage or spillway discharge are maintained for this site. However, it is known that the dam was overtopped by 1 foot following a flood in 1971.

c. Visual Observation

The valley below the dam is a steep rock gorge, which widens out 1/4 mile downstream at a rock quarry. The quarry is located downstream of the confluence of East Branch with West Branch which further increases the damage potential. As part of the more precise hydrologic study recommended in the assessment, the effect of West Branch on the downstream reach should be studied.

One half mile downstream are a restaurant and office. The elevation of these occupied buildings and their proximity to the stream confirm the "high" hazard potential of the dam. Siltation in the reservoir has greatly reduced its original capacity. The slopes around the lake are steep, and covered with grass and trees, but do not appear unstable.

d. Overtopping Potential

A storm of magnitude equivalent to the SDF would cause overtopping of the dam to a height of 6.1 feet. Computations indicate that the dam can pass approximately 10% of the PMF without overtopping the dam crest. Since one half the PMF is the Spillway Design Flood (SDF) for this dam, and since the hazard potential for loss of life downstream due to dam failure caused by overtopping is not greater than that which exists without failure, the spillway capacity fo the East Branch Reservoir Dam is assessed as "inadequate."

SECTION 6: STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

At the time of inspection, the condition of the dam gave rise to concern about its stability and adequacy to perform its present function. The concrete deterioration and seepage observed indicate a lack of recent maintenance. Inspection of the foundation indicated that the rock is potentially unstable, and the build-up of sediment behind the dam further endangers stability. The lack of an operable low-level outlet is not conducive to satisfactory operation of the dam. No undue misalignment or signs of movement were noted.

b. Design and Construction Data

No design computations were uncovered during the report preparation phase. No information on joint systems, mapped at the time of construction, is available, nor are other foundation parameters such as crushing strength and porosity of the rock. One drawing each of the present and original dams are the only data available.

c. Operating Records

No operating records are available relating to the stability of the dam.

d. Post-Construction Changes

The original construction was a masonry structure, built in 1888. In 1905 the present concrete buttress dam was constructed and since then no modifications to enhance stability are known to have taken place.

e. Static Stability

A static stability analysis was performed on the cross section. The validity of the results are, of course, a function of the assumptions made. The results, which are given in Appendix E, did yield acceptable factors of safety against sliding and overturning, but the overall stability of the foundation could not be analyzed because of a lack of data on the joint system.

f. Seismic Stability

The dam is located in Seismic Zone 1, as defined in Recommended Guidelines for Safety Inspection of Dams, as prepared by the Corps of Engineers. In general, projects located in Seismic Zones

0, 1 and 2 may be assumed to present no hazard from earthquakes, provided the static stability conditions are satisfactory and conventional safety margins exist. In this case, since the static stability has not been conclusively analyzed and is potentially questionable, the seismic stability must also be considered questionable, pending the results of further investigation.

SECTION 7: ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment

a. Safety

The dam has been inspected visually and a review has been made of the available engineering data. This assessment is subject to the limitations inherent in the visual inspection procedures stipulated by the Corps of Engineers for a Phase I report.

The safety of East Branch Reservoir Dam is in question because the discharge capacity of the dam and spillway is such that a flood of 1/2 PMF causes overtopping of the dam to a height of 6.1 feet.

The approximate static stability analysis performed for this dam indicates that factors of safety against movement are adequate under 1/2 PMF conditions but this does not include a foundation analysis and no definitive statement pertaining to the safety of the dam can be made without acquisition of the engineering properties of the foundation. The present dam has performed adequately since it was built in 1905 without failure or evidence of instability. Further, it should be noted that the dam structure survived a flood in 1971 whose high water mark was later measured to be 8.3 feet above the spillway crest.

b. Adequacy of Information

The information and data uncovered are not adequate to perform a comprehensive, definitive evaluation of the dam's stability.

c. Urgency

Studies to increase the present data on the bedrock, and an examination of the joint system geometry and seepage patterns, should be made in the next 3 months. The results of the study should be evaluated immediately upon acquisition by a qualified geotechnical engineer, to assess the static stability of the dam.

Studies to augment the spillway discharge capacity or to determine the hydrologic and hydraulic ability of the dam to withstand overtopping, should be undertaken within six months.

The existing dam plans and drawings should be annotated and updated to form a coherent as-built set within a reasonable period of time.

7.2 Remedial Measures

a. Alternatives for Increasing Spillway Capacity

If it is determined by a study of the dam's ability to withstand overtopping, that an increase in the spillway capacity is necessary to prevent instability, then the following alternatives are available.

1. Lower the weir crest elevation.

2. Widen the weir structure.

3. Any combination of the above alternatives.

b. Other Remedial Measures

1. Repair all areas of deteriorated concrete, and pressure grout the dam/rock interface where seepage is occurring and all foundation rock joints as determined by inspection.

2. Restore access to the low-level outlet valve and repair the valve if necessary.

3. Place mass concrete to fill the voids in the rock caused by mass-wasting.

c. Recommendations

1. Establish a flood-warning system for the downstream community within three months.

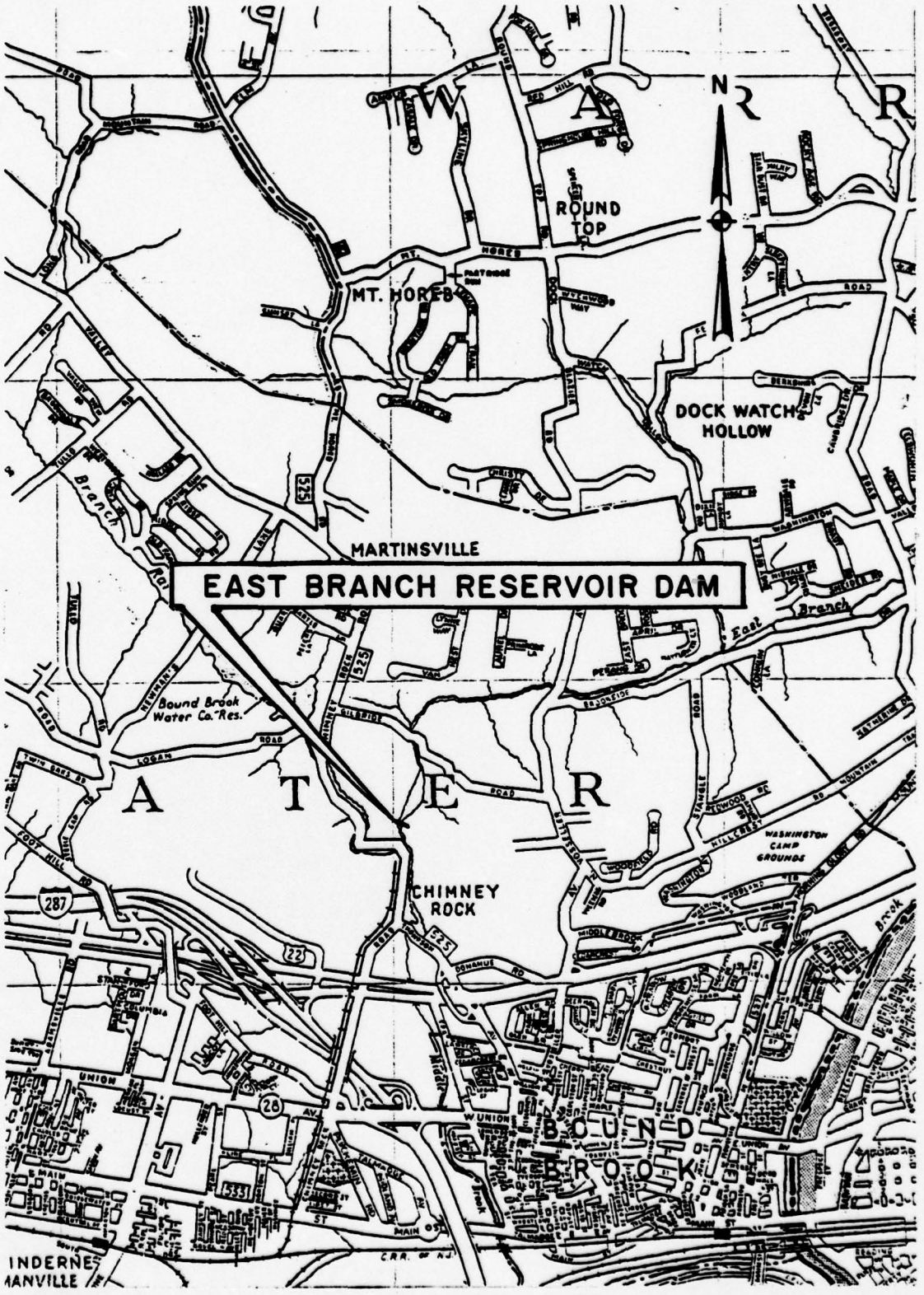
2. Dredge the sediment from the reservoir.

3. Consider removal of the dam as an alternative to repairing it.

d. O & M Procedures

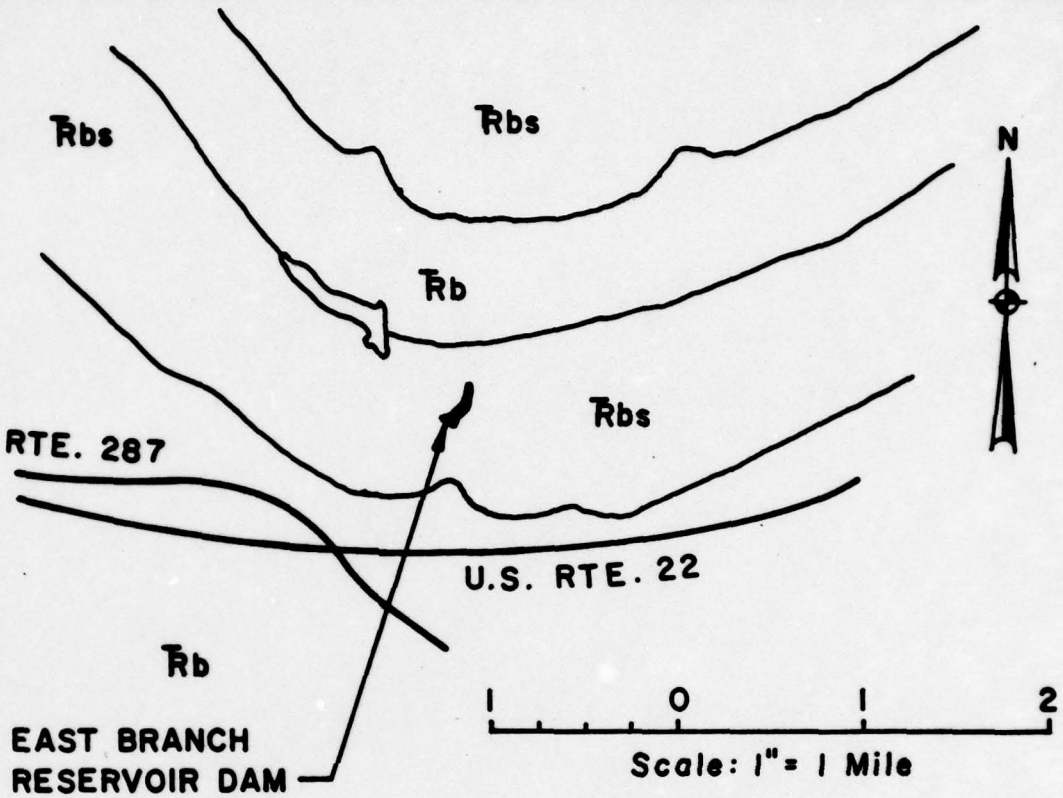
If recommendation 3 is not followed, then a formalized program of annual inspections of the dam by an experienced party should be initiated, utilizing the standard visual check list in this report. A headwater gage should be installed in the dam, and read out during severe rain storms and at routine operating and maintenance and operating events of the dam and the lake. Movement of the dam should be monitored regularly by means of surveying monuments, and any change in seepage rates should be noted.

PLATES



VICINITY MAP

PLATE 1



LEGEND

TRIASSIC

Trbs Basalt Flows
Fine-Grained Trap Rock in Extensive Flows, Chiefly in the Watchung Mountains; in part Vesicular.

Trb Brunswick Formation
Soft Red Shale with Sandstone Beds.

— Contact

GEOLOGIC MAP
EAST BRANCH RESERVOIR

PLATE 2

BOUND BROOK—WATER WORKS
DAM
No. 1

ISAAC S. CASSIN,
CONSULTING ENGINEER.

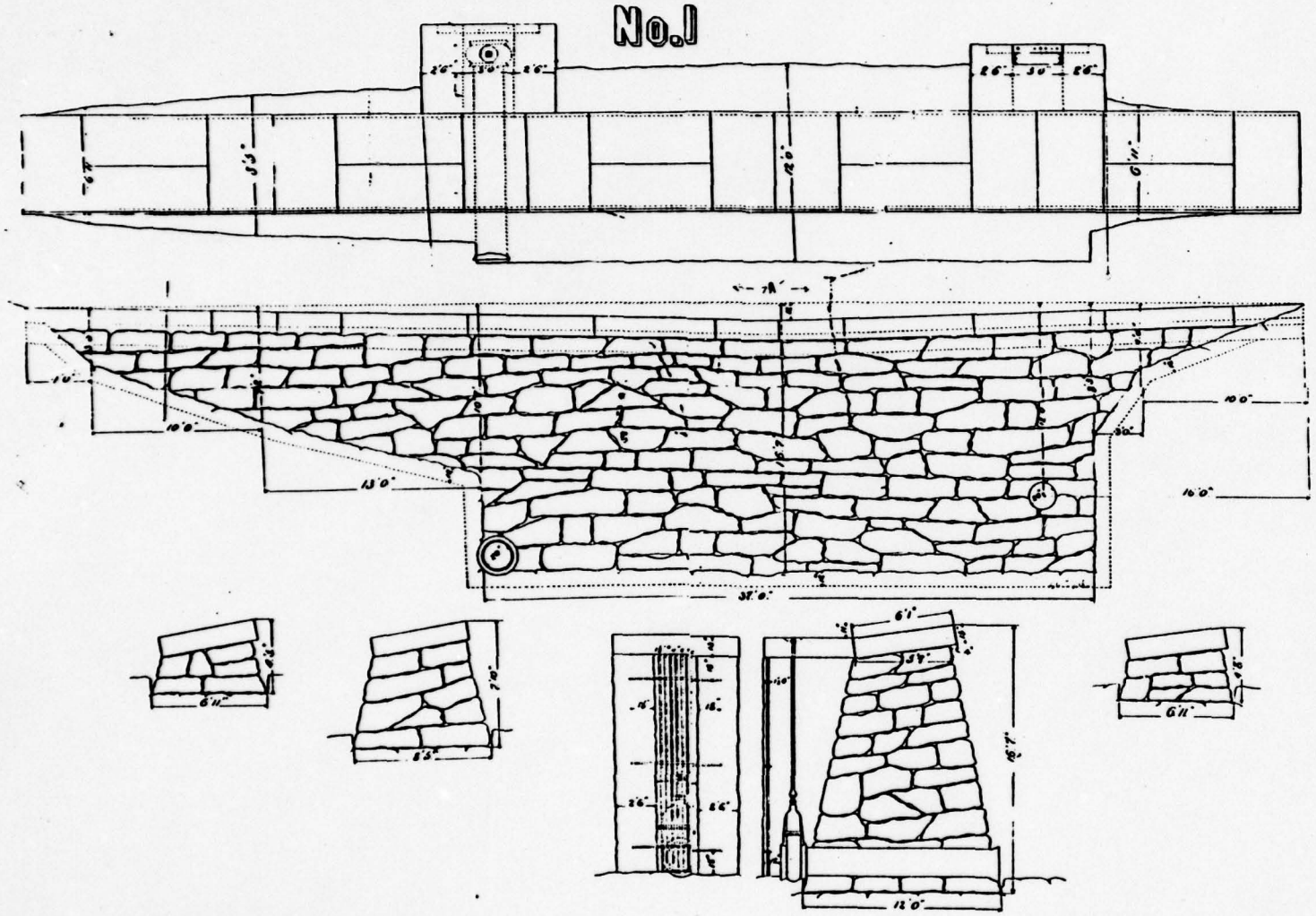
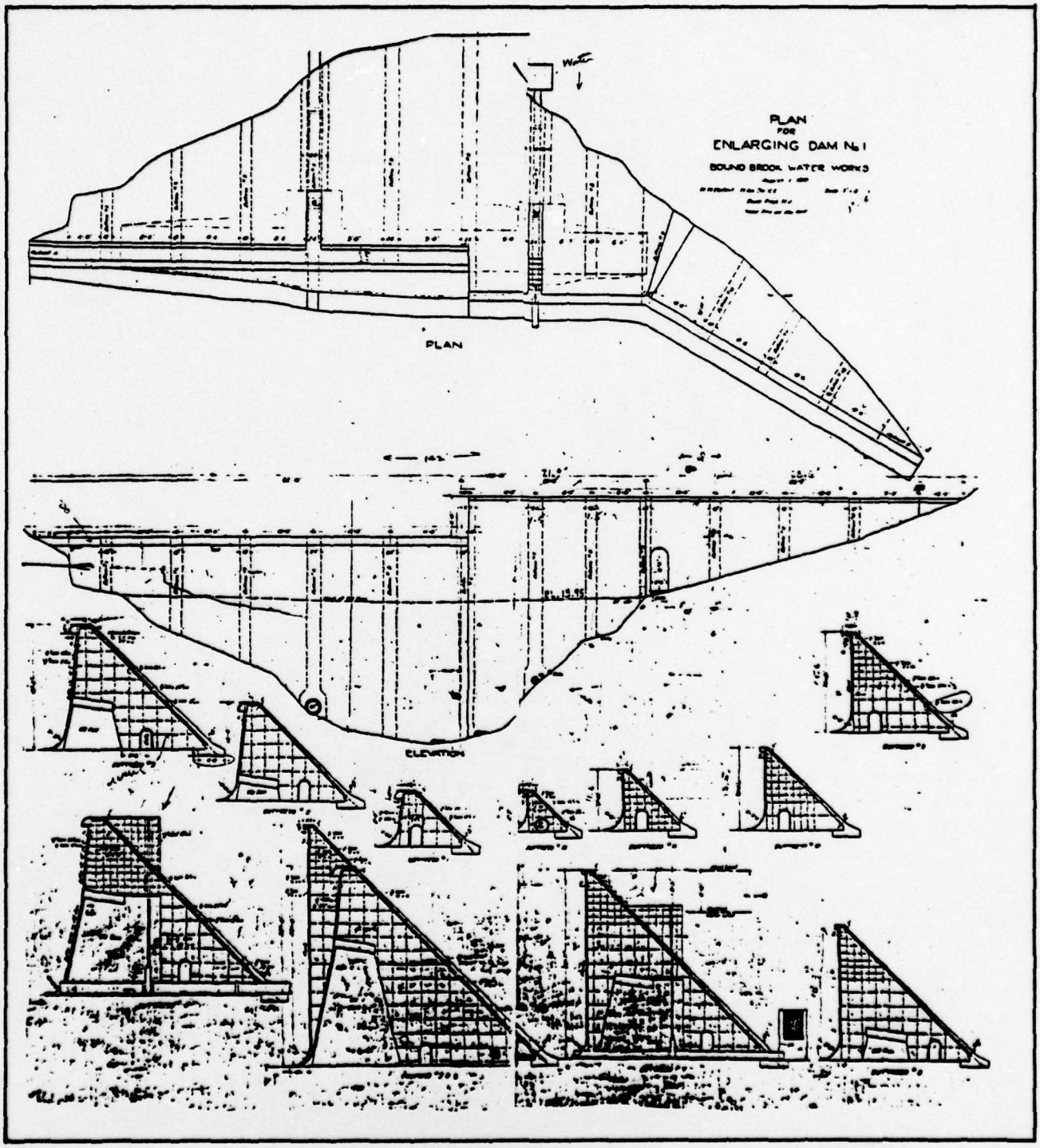


PLATE 3



APPENDIX A

CHECK LIST - VISUAL OBSERVATIONS

CHECK LIST - ENGINEERING, CONSTRUCTION, MAINTENANCE DATA

CHECK LIST
VISUAL INSPECTION

PHASE I

Name of Dam East Branch Reservoir County Somerset State New Jersey Coordinators NJDEP

Date(s) Inspection May 1, 1979 Weather Sunny Temperature 70°F

Pool elevation at Time of Inspection 140' M.S.L. Tailwater at time of Inspection 117' M.S.L.

Inspection Personnel:

Frederic R. Harris

S. Roth
T. Lynch
H. King
C. Chin

New Jersey DEP

J. Moyle

Owner/Representative

None attended.

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
SEEPAGE OR LEAKAGE	There is general leakage observable, coming from the construction joints in the buttress slab on the left abutment below the prevailing pool elevation. Also at contact between buttress face slab and abutments. Total left bank leakage estimated at 10-15 gpm.	Pressure-grout construction joints and dam/rock interface.
STRUCTURE TO ABUTMENT/ EMBANKMENT JUNCTIONS	The structure to rock abutments are fair, where visible, in the left abutment, with some leakage points.	Pressure-grout leakage points.
DRAINS	There are no drains provided.	No action.
WATER PASSAGES	A 10 inch diameter waterline has been abandoned on the left abutment.	No action.
FOUNDATIONS	Solid basaltic rock, vertically jointed. Dam is built on rock foundation and on top of an existing lower masonry dam.	Some mass-wasting of rock has taken place and should be repaired with mass concrete.

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
SURFACE CRACKS **CONCRETE SURFACES**	Concrete is in an advanced state of deterioration due to freeze-thaw action. The upstream face of the buttress slab is severely deteriorated above the waterline. The downstream face of the abutment slab is severely deteriorated in places, areas up to 10 square feet are deteriorated to a 4 inch depth, exposing reinforcing bars. Concrete surface is very poorly formed and rough.	Repair deteriorated concrete with epoxy cement.
STRUCTURAL CRACKING	No major cracking was observed.	
VERTICAL & HORIZONTAL ALIGNMENT	Original alignment has been preserved. No past motion is readily apparent.	Monitor alignment with surveying monuments.
MONOLITH JOINTS	None observed.	
CONSTRUCTION JOINTS	Poor horizontal joints can be observed on the downstream face of the buttress slab, with reservoir water leaking through, but without head behind the leakage.	Pressure-grout the joints.

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
CRACKING & SPALLING OF CONCRETE SURFACES IN STILLING BASIN	None. Natural rock dowsntream of dam is used as an energy dissipator. Mass-wasting of rock in this area has been caused by frost action.	Repair with mass concrete.
INTAKE STRUCTURE	None	
OUTLET STRUCTURE	None	
OUTLET FACILITIES	None in working condition. A 20 inch dia. low-level outlet is shown on the plans, but access to it on the river abutment is not possible with portable ladders and this facility is judged inaccessible and not available in an emergency.	Restore access to and operability of low-level outlet.
EMERGENCY GATE	None operable.	

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
CONCRETE WEIR		
	Concrete buttress weir surfaces are deteriorated and surface spalled. Crest very spalled (Local ± 6"). Approximately 20-25 cfs of water over the crest.	Repair concrete with epoxy cement.
APPROACH CHANNEL		
None		
DISCHARGE CHANNEL		
Natural rock gorge.		
BRIDGE AND PIERS		
None		

INSTRUMENTATION

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
MONUMENTATION/SURVEYS		
None		Install a benchmark nearby to MSL datum.
OBSERVATION WELLS		
None		
WEIRS		
None		
PIEZOMETERS		
None		
OTHERS		
		Install headwater and tailwater gages.

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
SLOPES Reservoir is in a steep "v" shaped valley. Reservoir rim at pool level is 1:4, steeper further back from reservoir.		
SEDIMENTATION Considerable sedimentation is in evidence. Depth of silt could not be determined.		Determine depth of silt, and dredge from reservoir.
USE Recreational only.		
SHORELINE BUILDINGS None		

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Very steep rock gorge immediately downstream of dam. Further drop downstream of dam 15-20 feet, no major obstructions or bends.	
SLOPES	"V" Shaped valley, 1:3 side slopes. Further downstream, stream is adjacent to Route 525 (Chimney Rock Road).	
APPROXIMATE NUMBER OF HOMES AND POPULATION	At junction 1/3 of a mile downstream with main creek, there is a rock quarry on the right bank. Could be flood damage for hypothetical dam failure one mile downstream. There is a quarry office and a restaurant with a day population of 15-20. Don't believe dam impounds enough water to cause damage in case of failure further downstream of these buildings because of valley storage.	

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

ITEM	REMARKS
PLAN OF DAM	Available.
REGIONAL VICINITY MAP	County map - Somerset County. U.S.G.S. Quad sheet - Bound Brook
CONSTRUCTION HISTORY	Originally constructed in 1888, reconstructed in 1905.
TYPICAL SECTIONS OF DAM	Available.
HYDROLOGIC/HYDRAULIC DATA	None available.
OUTLETS - PLAN	None available.
- DETAILS	None available.
- CONSTRAINTS	None available.
- DISCHARGE RATINGS	None available.
RAINFALL/RESERVOIR RECORDS	None available.

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
(continued)

ITEM	REMARKS
DESIGN REPORTS	None available.
GEOLOGY REPORTS	Rutgers University - Eng. Soil Survey for Somerset County. Quad sheet overlay.
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	None available.
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	None available.
POST-CONSTRUCTION SURVEYS OF DAM	None available.
BORROW SOURCES	None available.
SPILLWAY PLAN - SECTIONS - DETAILS	1888 and 1905 plans of the structure.

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
(continued)

ITEM	REMARKS
OPERATING EQUIPMENT PLANS AND DETAILS	None available.
MONITORING SYSTEMS	None.
MODIFICATIONS	In 1905, the present dam was constructed on top of the original structure.
HIGH POOL RECORDS	The water rose over the dam to an elevation of 148.3 during a 1971 flood.
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None.
PRIOR ACCIDENTS OF FAILURE OF DAM	
- DESCRIPTION	None.
- REPORTS	None.
MAINTENANCE OPERATION RECORDS	None.

APPENDIX B

PHOTOGRAPHS

(All photographs taken May 1, 1979)

Photo No. 1 - Overall view of dam from downstream. Note the massive rock foundation and abutments.

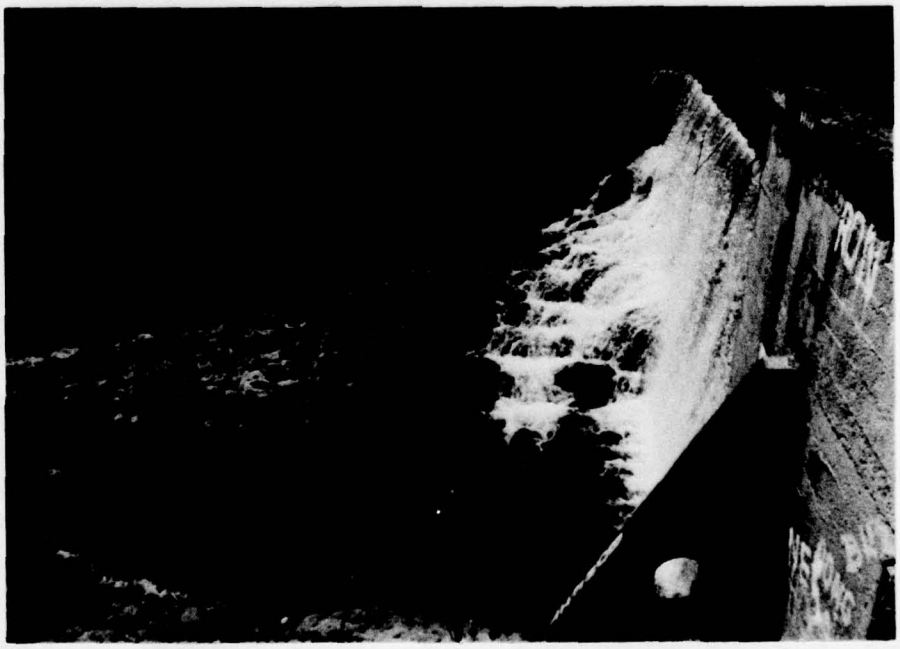


Photo No. 2 - View of spillway crest from the left bank.

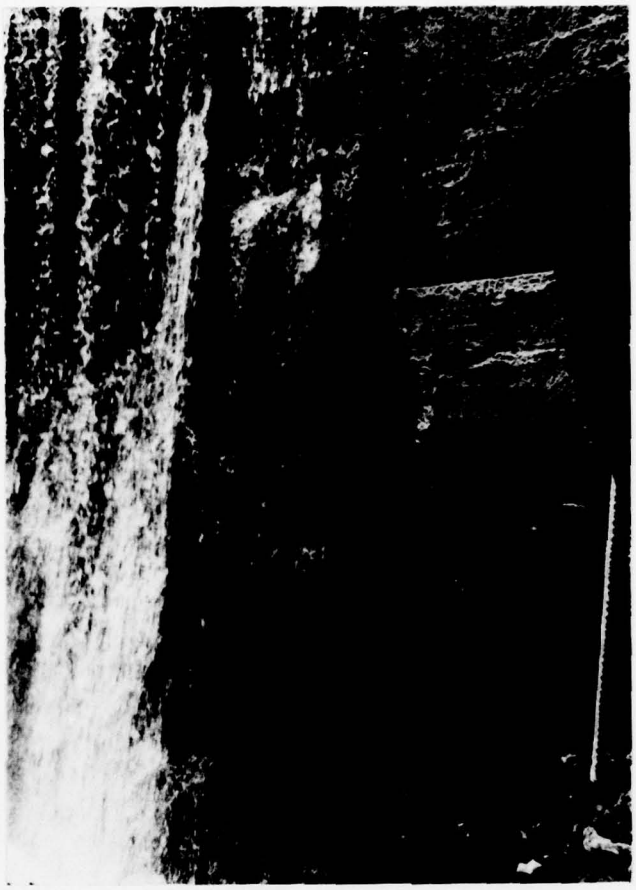


Photo No. 3 - Detail of the structure to rock abutment, on the left downstream side. Note the seepage and the extensive deterioration of the concrete.

Photo No. 4 - View of inspection tunnel entrance and buttress. Note seepage at the base of the structure, and deteriorated concrete.

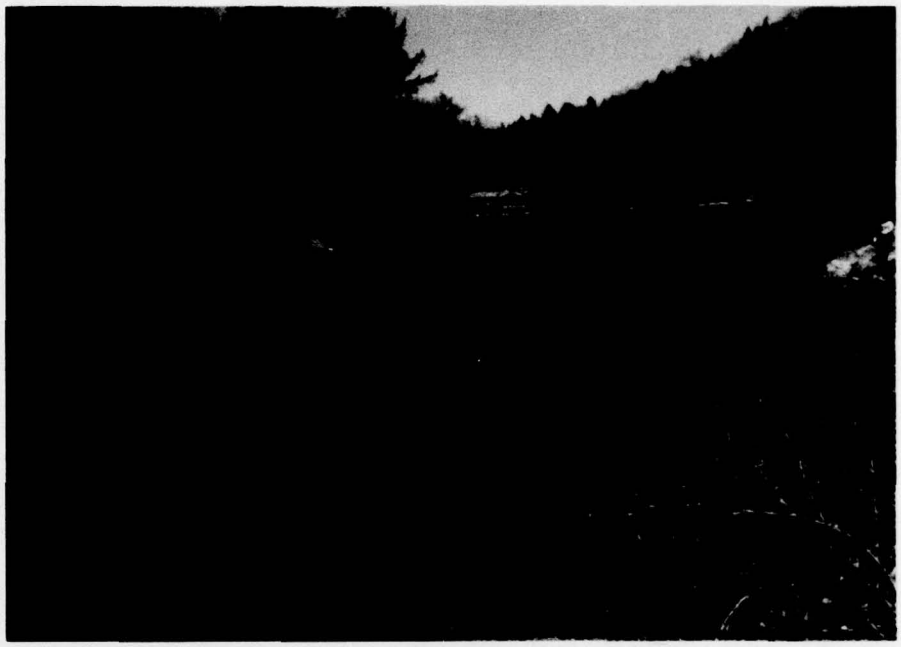


Photo No. 5 - View of reservoir looking upstream.

Photo No. 6 - View of the downstream channel. Note steep rock gorge.

APPENDIX C

SUMMARY OF ENGINEERING DATA

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

Name of Dam: East Branch Reservoir

Drainage Area Characteristics: Residential and wooded.

Elevation Top Normal Pool (Storage Capacity): 140' MSL (77 acre-feet).

Elevation Top Flood Control Pool (Storage Capacity): N/A

Elevation Maximum Design Pool: (SDF) 153.4' MSL (270 acre-feet)

Elevation Top Dam: 147.3' MSL (163 acre-feet)

SPILLWAY CREST

a. Elevation 140' (MSL)

b. Type Concrete Triangle overflow.

c. Width 2'

d. Length 62.8'

e. Location Spillover Right side of dam.

f. No. and Type of Gates None.

OUTLET WORK

a. Type 20 inch ø low-level outlet (inoperable).

b. Location Middle of the spillway.

c. Entrance Inverts 119' (MSL)

d. Exit Inverts 119' (MSL)

e. Emergency Draindown Facilities None.

HYDROMETEOROLOGICAL GAGES

a. Type N/A

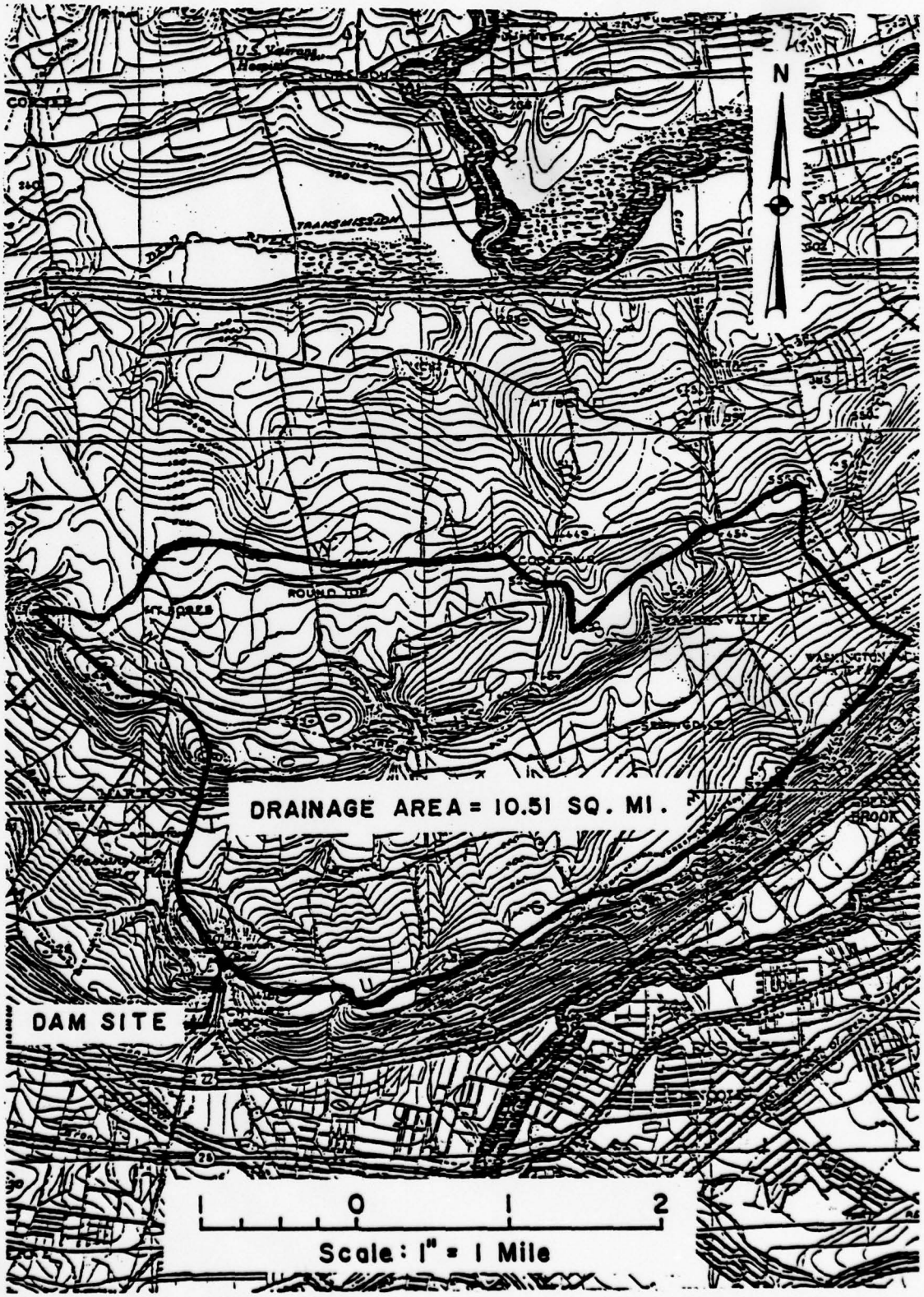
b. Location N/A

c. Records N/A

MAXIMUM NON-DAMAGING DISCHARGE 4620 cfs.

APPENDIX D

HYDROLOGIC COMPUTATIONS



EAST BRANCH RESERVOIR DAM
DRAINAGE BASIN

FREDERIC R. HARRIS, INC.
CONSULTING ENGINEERS

SUBJECT East Branch Reservoir
COMPUTED BY BK CHECKED BY
SHEET NO. 1 OF
JOB NO. 10-A20-01
DATE

SIZE CLASSIFICATION

SURFACE AREA OF MAIN IMPOUNDMENT	9.2 Acre
AVERAGE DEPTH AT RESERVOIR	10± Ft (Estimate)
STRUCTURAL HEIGHT OF DAM	32.5'
SIZE CLASSIFICATION	SMALL

HAZARD POTENTIAL CLASSIFICATION

D/S HAS, OFFICES, INDUSTRIES & RESTAURANT IN FLOOD PATH

HAZARD POTENTIAL CLASSIFICATION	HIGH
RECOMMENDED SDF	½ to PMF

HYDROLOGIC ANALYSIS

THE HEC-1DB WILL BE USED TO ROUTE THE FLOOD USING SCS TRIANGULAR UNIT HYDROGRAPH WITH CURVILINEAR TRANSFORMATION

D.A. = 10.5 SQ. MI

PRECIPITATION

FROM FIG 15, ZONE 6 (REF. "DESIGN OF SMALL DAM" 1977")

Probable Max. Precipitation = 26" for 6 HR Duration

AND 10 Sq. mi Area

Duration (HRS)	% PMP
6	100
12	109
24	117

VALUES ARE REDUCED by 20% to Adjust For Misalignment on Basin & Storm Isohetals.

INFILTRATION DATA

Hydrologic Soil Group (Mostly Ib-46 Ge, & Ib4) D

Soil type: Silts and Silty clays with variable shallow depth to bedrock, the steep slopes

USE INITIAL INFILTRATION 1.0 inch

Constant infiltration 0.1 inch

TIME CONCENTRATION

1) Estimating T_c from velocity Estimate & Water course Length

	Slope	vel.	Remark
Overland flow	$\frac{220}{3000}$	2.0	Wooded
REACH	$\frac{160}{21000}$	1.5	

$$T_c = \left(\frac{3000}{2} + \frac{21000}{1.5}\right)\frac{1}{3600} = 4.31 \text{ hr}$$

2) Estimating T_c from velocity & water course length

Assume Travel thru reservoir is at same velocity for all length as the stream channel

$$T_c = \frac{24000}{1.5 \times 3600} = 4.44 \text{ hr}$$

3). FROM Nomograph "Design of Small Dam"
SAME AS CALIF. Highway

$$T_c = \left(\frac{11.9\,L3}{H}\right)^{0.385} = \left(\frac{11.9\,(4.55)^3}{380}\right)^{0.385}$$

$$= 1.52 \text{ hr}$$

TIME OF CONC. - CONTINUED

4) Using FAA formula for surface flow (AIRFOR DRAINAGE)

$$T_{C\,(MIN)} = \frac{1.8\,(1.1-C)\sqrt{D}}{\sqrt[3]{S}}$$

$D = 24000'$
$C = 0.5$ Steep slope with 30% urban
$S = \frac{380}{24000} = 1.58\%$

$T_C = 2.4$ hr.

5) Kirpich Method

$$T_C = 0.0078\,K^{.77} \qquad K = \frac{L}{\sqrt{S}} \qquad S = \frac{H}{L}$$

$$T_C = 0.0078\left(\frac{24000}{\sqrt{\frac{380}{24000}}}\right)^{.77} = 1.51 \text{ hr.}$$

6) G. B WILLIAMS Flood Committee

$$t = 0.908\,L\,\sqrt[5]{\frac{I}{FD}} \qquad \text{(in hrs)}$$

L = the Length of Catchment in miles
D = the Diameter in Miles of a circle having the same Area
F = the catchment slope express in %

$$t = 0.908\,(4.55)\sqrt[5]{\frac{1}{1.583(3.66)}} = 2.91 \text{ hr.}$$

USE $T_C = 2.9$ hr
Lag $= 0.6\,T_C = 1.74$ hr

LAG = 1.74 hr

FREDERIC R. HARRIS, INC.
CONSULTING ENGINEERS

SUBJECT East Branch Reservoir
COMPUTED BY BK CHECKED BY
SHEET No. 5 OF
JOB No. 10-A20-01
DATE

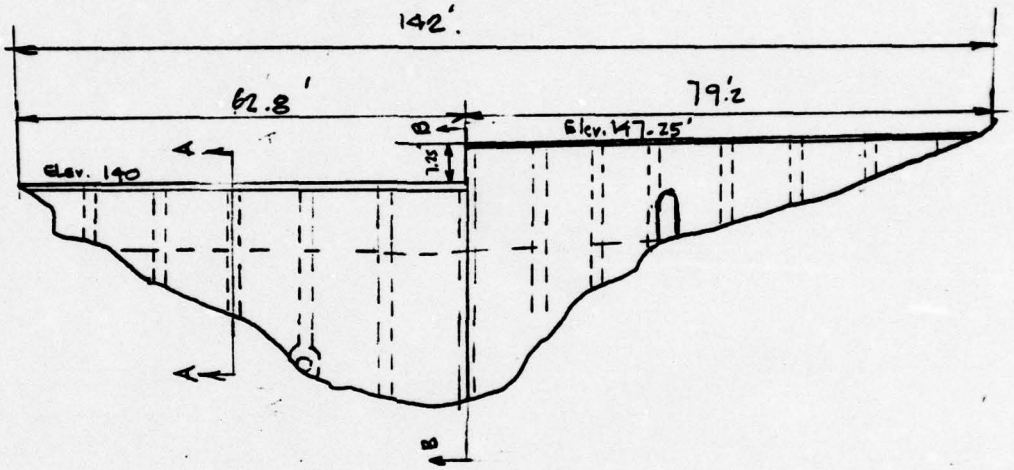
Elevation – Area – Capacity Relationship

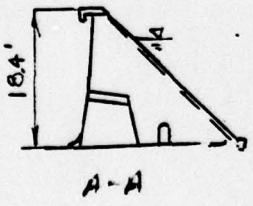
Information Obtained from U.S.G.S. Maps

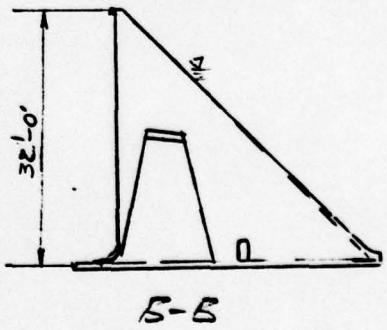
Elev.	115.0*	140.0	160
Surface Area (Ac)	0	9.2	27.6

* Bottom of Lake at Spillway (Estimate)

HEC-1DB program will develop Storage Capacity From surface Area & Elevation







$L_1 = 62.8$ $C_1 = 3.73$ (Ref. King & Brater tab 5-11)

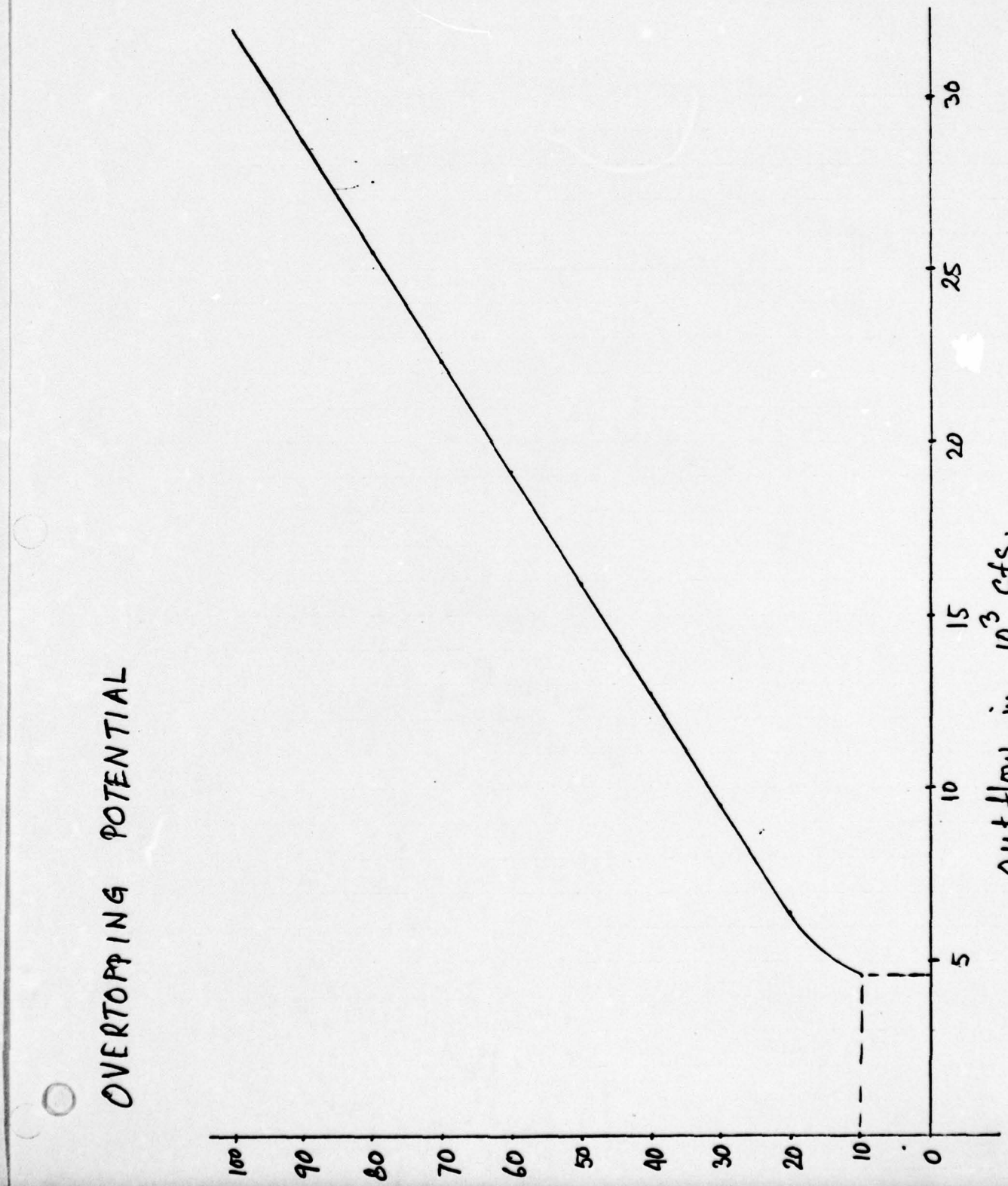
$L_2 = 79.2$ $C_2 = 3.73$ (dam)

HEC-1 DB program Develops STAGE DISCHARGE CURVE

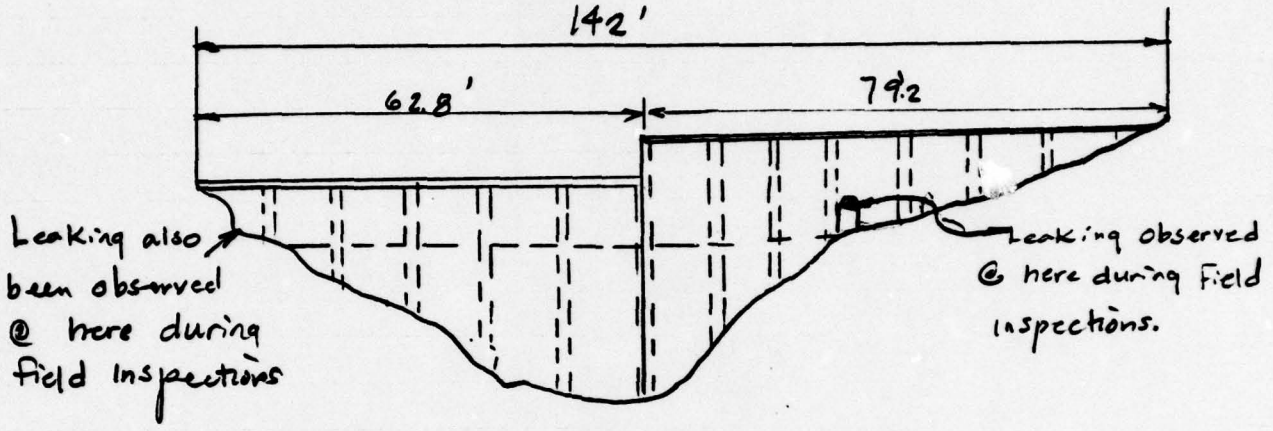
FREDERIC R. HARRIS, INC.
CONSULTING ENGINEERS

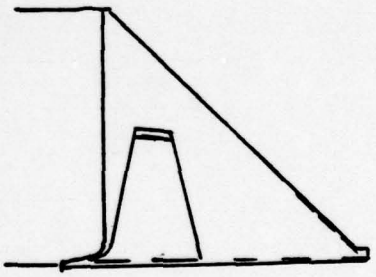
SUBJECT East Branch Reservoir
COMPUTED BY S.B CHECKED BY

SHEET No. 7 OF
JOB No. 10-A 20-01
DATE

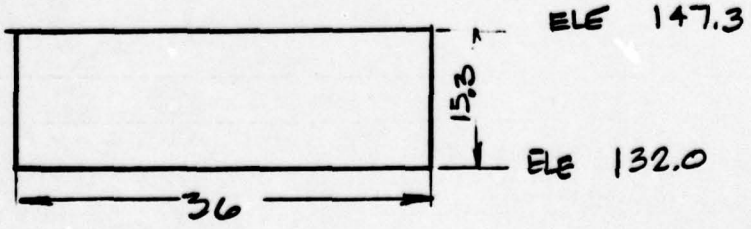


BREACH ANALYSIS

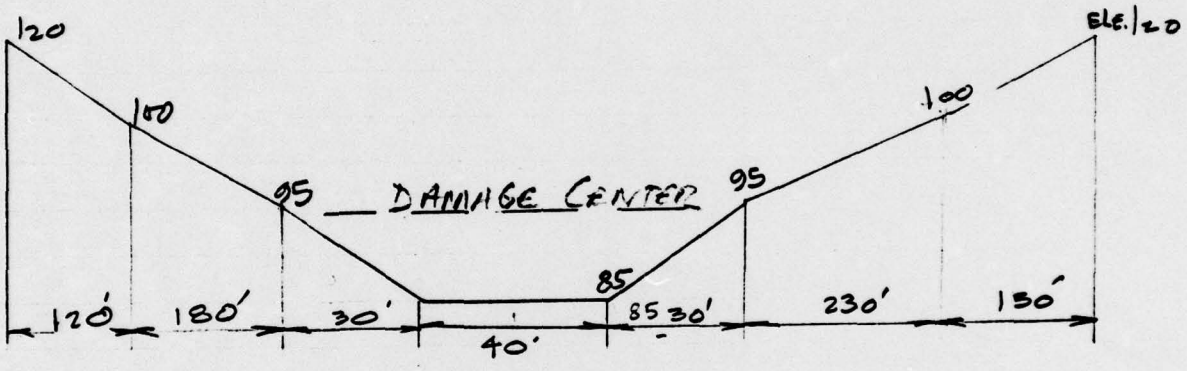




ASSUME BREACH BEGINS TO DEVELOP WHEN RESERVOIR STAGE REACH ELE 150.0 TIME OF FULLY DEVELOPED = 1.0 hr



FULLY DEVELOPED BREACH

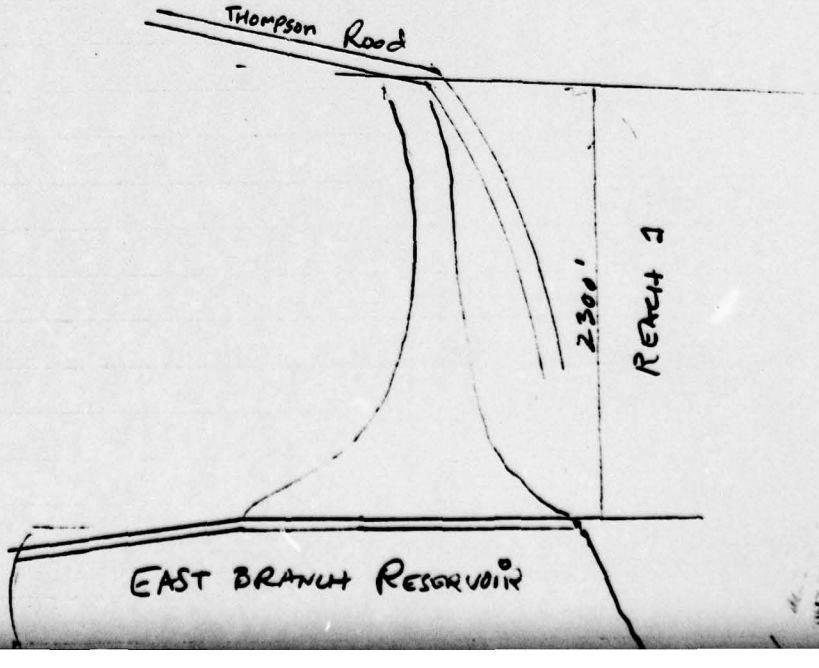


CROSS SECTION

END OF REACH 1

$S = 0.0117$

$\Delta H = \frac{112.3 - 85.1}{2300'}$



Overtopping Over Dam

% PMF	Q	Max WSEL	Max. Feet above Dam	Duration of Flooding HRS	Max W.S.El 2,300 Ft D/S
10	4620	145.7	0	0	90.4
20	6354	148.6	1.3	2.25	92.8
30	9539	150.4	3.1	3.75	94.6
40	12721	152.0	4.7	5.25	96.0
50	15902	153.4	6.1	5.75	97.0
60	19083	154.7	7.4	6.50	97.9
70	22263	155.9	8.6	6.75	98.6
80	25443	157.0	9.7	7.0	99.3
90	28623	158.1	10.8	7.50	99.9

FREDERIC R. HARRIS, INC.
CONSULTING ENGINEERS

SUBJECT N.J. Dam Inspections SHEET NO. 10 OF
East Dr. Pond
JOB NO. 10-A20-01
COMPUTED BY S.B. CHECKED BY
DATE June 1979

FREDERIC R. HARRIS, INC.
CONSULTING ENGINEERS

SUBJECT N.J. Dam Inspection — East Branch Res.
SHEET NO. 11 OF
JOB NO. 10-A20-01
COMPUTED BY S.B. CHECKED BY
DATE July, 1979

Dam Break Analysis:

Without Dam failure the maximum stage is observed as 97.0' MSL* at $\frac{1}{2}$ PMF.

With Dam Break there will be no change in the stage at a section 2300' Downstream of Dam.

Dam will begin to fail at 16 hours

* By visual inspection, the restaurant and office at the end of reach 1 have first floor elevations below 97' MSL and the danger therefore exists of loss of life in these buildings.

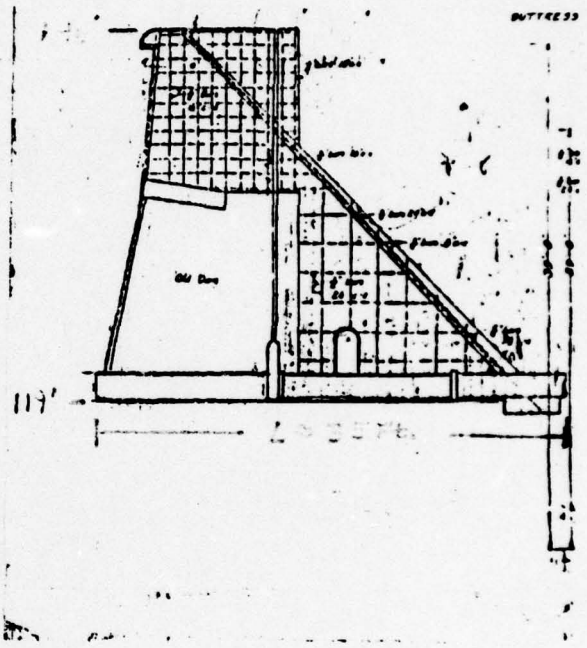
FREDERIC R. HARRIS, INC.
CONSULTING ENGINEERS

SUBJECT NEW JERSEY DAM INSPECTION SHEET NO. 12 OF
EAST BRANCH RESERVOIR DAM JOB NO. 10-A20-01
COMPUTED BY JFZ CHECKED BY DATE

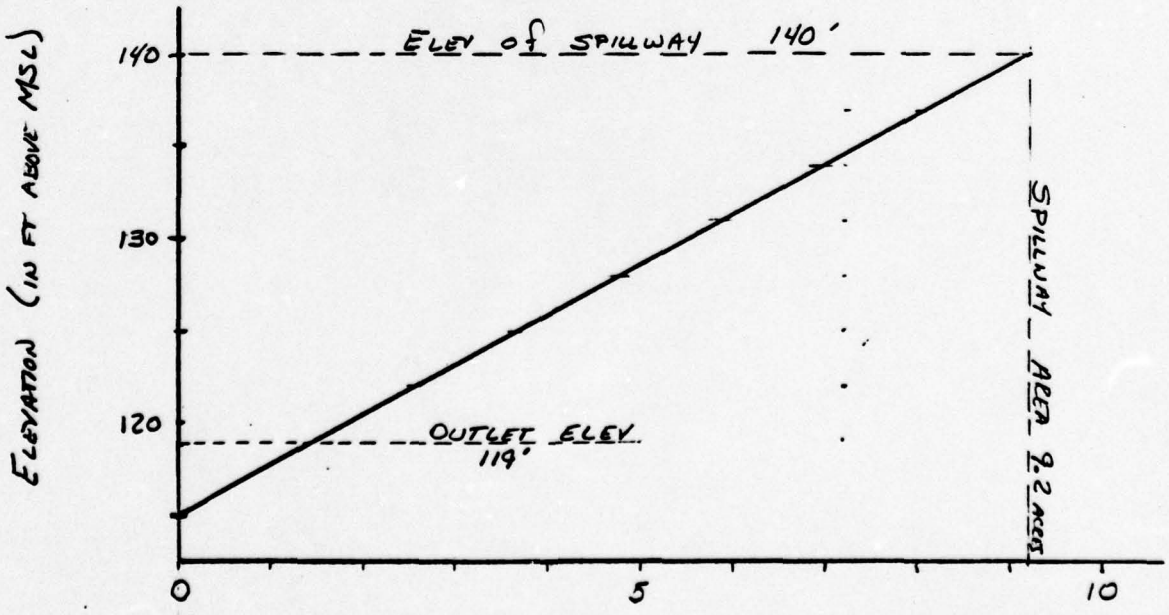
DAM DRAWDOWN CALCULATION

ELEV @ PIPE INVERT 119'
ELEV @ SPILLWAY 140'
ELEV @ UPSTREAM INVERT 115'

PIPE IS A 20" ϕ



AREA - HEAD RELATIONSHIP *



* THIS ASSUMES A STRAIGHT LINE RELATIONSHIP FROM THE NORMAL WATER SURFACE ELEVATION TO STREAM BED

b) ELEVATION - DISCHARGE RELATIONSHIP FOR THE LOW LEVEL OUTLET

20" ϕ CAST IRON PIPE

TAILWATER DEPTH ASSUMED @ 2/3 d = 2/3(1.67') = 1.11 FT

D/S WATER SURFACE ELEV = 119 + 1.11 = 120.11 FT

AREA = $\pi d^2/4$ = 2.18 SQ FT
LENGTH = 35 FT (ESTIMATED)

HEAD LOSSES

ENTRANCE	$0.5\ v^2/2g$
EXIT	$1.0\ v^2/2g$
FRICTION	$.64\ v^2/2g$

$$h_f = \frac{n^2 L 2g}{(1.486)^2 R^{4/3}}\ v^2/2g$$

$$= \frac{(.014)^2(35)2(32.2)}{(1.486)^2\left(\frac{1.67}{4}\right)^{4/3}}$$

$$= .64\ v^2/2g$$

$\therefore$ HEAD LOSS = $2.14\ v^2/2g$

$$= \frac{2.14\ Q^2}{2g\ A^2}$$

$$= 0.007 Q^2$$

$$Q = C_d \cdot A \cdot \sqrt{2g\ (H - \text{HEAD LOSS})}$$

$$= 0.8 \cdot 2.18 \cdot \sqrt{64.4\ (H - .007Q^2)}$$

$$Q^2 = 195.9\ (H - .007 Q^2)$$

$$2.37 Q^2 = 195.9 H$$

$$Q = 9.09 \sqrt{H}$$
$$= 9.09 \sqrt{Z - 119}$$

c) DRAINAGE AREA = 10.57 SQ MI
INFLOW @ 2 cfs/SQ MI = 21 cfs

EL ①	AREA (Ac) ②	AVG AREA (Ac) ③	VOL (Ac-Ft) ④	HEAD @ OUTLET (FT) ⑤	OUTLET Q $9.09\sqrt{H}$ (cfs) ⑥	t_1 TIME TO DRAW RESERVOIR (DAYS) ④ x 43,560 / ⑥ x 86,400	t_2 TIME TO DRAW INFLOW DAYS $\frac{21 \times t_1}{Q}$	TOTAL TIME (HRS) $t_1 + t_2$
140	9.2							
		8.63	25.88	19.5	40.14	.32	.17	.49
137	8.05							
		7.50	22.50	16.5	36.92	.31	.18	.49
134	6.95							
		6.40	19.20	13.5	33.40	.29	.18	.47
131	5.85							
		5.30	15.90	10.5	29.45	.27	.19	.46
128	4.75							
		4.18	12.53	7.5	24.89	.25	.21	.46
125	3.6							
		3.08	9.23	4.5	19.28	.24	.26	.50
122	2.55							
		1.98	5.93	1.5	11.13	.27	.51	.78
119	1.4							
						1.95 DAYS		3.65 DAYS

1 ACRE FT = 43,560 FT³
1 DAY = 86,400 SEC

HEC1-DB

COMPUTER PRINT-OUT

```
OOD HYDROGRAPH PACKAGE (HEC-1)
N SAFETY VERSION      JULY 1978
LAST MODIFICATION  26 FEB 79
```

```
 1              A1      N.J. DAM INSPECTION
 2              A2      EAST BRANCH RES.
 3              A3      MULTY RATIO PMF ROUTING
 4              B   150       0      15       0       0       0       0       0       0       0
 5              B1    5
 6              J     1       9       1
 7              J1  .9      .8      .7      .6      .5      .4      .3      .2      .1
 8              K     0    LAKE                                      1
 9              K1      INFLOW HYDROGRAPH TO EAST BRANCH RESERVOIR
10              M     1       2    10.5            10.5                              1
11              P     0      26     100     109     117
12              T                                                     1      .1
13              W2          1.74
14              X    -1   -0.05       2
15              K     1     DAM                                       1
16              K1      ROUTING THROUGH RES.
17              Y                                     1       1
18              Y1    1                                         -147.3
19              SA    0     9.2   27.6
20              SE  115     140     160
21              SS  140    62.8    3.73     1.5
22              SD 147.3   3.73     1.5    79.2
23              K     1    2300                                       1
24              K1      ROUTE HYDROGRAPH TO REACH 1(2300 FT D/S)
25              Y                                     1       1
26              Y1    1                                           -1
27              Y6  .07     .04     .07      85     120    2300   .0117
28              Y7  500     120     620     100     800      95     830      85     870      85
29              Y7  900      95    1130     100    1280     120
30              K    99
```

PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

RUNOFF HYDROGRAPH AT	LAKE
ROUTE HYDROGRAPH TO	DAM
ROUTE HYDROGRAPH TO	2300
END OF NETWORK	

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  26 FEB 79
**********

RUN  DATE= 79/07/10.
     TIME= 15.38.35.


                    N.J. DAM INSPECTION
                    EAST BRANCH RES.
                    MULTY RATIO PMF ROUTING

                                JOB SPECIFICATION
          NO      NHR     NMIN     IDAY     IHR     IMIN    METRC     IPLT     IPRT    NSTAN
         150       0       15        0       0        0        0        0        0        0
                                   JOPER      NW     LROPT    TRACE
                                       5       0        0        0


                            MULTI-PLAN ANALYSES TO BE PERFORMED
                                NPLAN= 1 NRTIO= 9 LRTIO= 1
                RTIOS=    .90     .80     .70     .60     .50     .40     .30     .20     .10

**********          **********          **********          **********          **********

                                SUB-AREA RUNOFF COMPUTATION

                    INFLOW HYDROGRAPH TO EAST BRANCH RESERVOIR

                               ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                               LAKE        0       0       0       0       0       1       0       0

                                        HYDROGRAPH DATA
              IHYDG    IUHG    TAREA    SNAP    TRSDA    TRSPC    RATIO   ISNOW   ISAME   LOCAL
                  1       2    10.50    0.00    10.50     0.00    0.000       0       1       0

                                        PRECIP DATA
                          SPFE     PMS      R6     R12     R24     R48     R72     R96
                          0.00   26.00  100.00  109.00  117.00    0.00    0.00    0.00
TRSPC COMPUTED BY THE PROGRAM IS  .802

                                        LOSS DATA
          LROPT   STRKR   DLTKR   RTIOL   ERAIN   STRKS   RTIOK   STRTL   CNSTL   ALSMX   RTIMP
              0    0.00    0.00    1.00    0.00    0.00    1.00    1.00     .10    0.00    0.00

                                    UNIT HYDROGRAPH DATA
                                TC=  0.00    LAG=  1.74

                                    RECESSION DATA
                              STRTQ=   -1.00    QRCSN=    -.05    RTIOR= 2.00

          UNIT HYDROGRAPH 37 END OF PERIOD ORDINATES, TC=    0.00 HOURS, LAG=   1.74  VOL= 1.00
        146.     439.     852.    1465.    2101.    2536.    2703.    2700.    2517.    2251.
       1919.    1500.    1170.     936.     751.     618.     499.     393.     320.     258.
        205.     165.     133.     106.      86.      70.      56.      45.      36.      29.
         25.      20.      16.      12.       8.       5.       1.

0                               END-OF-PERIOD FLOW
  HO.DA  HR.MN  PERIOD   RAIN   EXCS   LOSS    COMP Q       HO.DA  HR.MN  PERIOD   RAIN   EXCS   LOSS    COMP Q
```

1.01	.15	1	.03	0.00	.03	10.
1.01	.30	2	.03	0.00	.03	9.
1.01	.45	3	.03	0.00	.03	9.
1.01	1.00	4	.03	0.00	.03	8.
1.01	1.15	5	.03	0.00	.03	7.
1.01	1.30	6	.03	0.00	.03	7.
1.01	1.45	7	.03	0.00	.03	6.
1.01	2.00	8	.03	0.00	.03	6.
1.01	2.15	9	.03	0.00	.03	6.
1.01	2.30	10	.03	0.00	.03	5.
1.01	2.45	11	.03	0.00	.03	5.
1.01	3.00	12	.03	0.00	.03	5.
1.01	3.15	13	.03	0.00	.03	4.
1.01	3.30	14	.03	0.00	.03	4.
1.01	3.45	15	.03	0.00	.03	4.
1.01	4.00	16	.03	0.00	.03	3.
1.01	4.15	17	.03	0.00	.03	3.
1.01	4.30	18	.03	0.00	.03	3.
1.01	4.45	19	.03	0.00	.03	3.
1.01	5.00	20	.03	0.00	.03	3.
1.01	5.15	21	.03	0.00	.03	2.
1.01	5.30	22	.03	0.00	.03	2.
1.01	5.45	23	.03	0.00	.03	2.
1.01	6.00	24	.03	0.00	.03	2.
1.01	6.15	25	.08	0.00	.08	2.
1.01	6.30	26	.08	0.00	.08	2.
1.01	6.45	27	.08	0.00	.08	2.
1.01	7.00	28	.08	0.00	.08	2.
1.01	7.15	29	.08	.04	.04	7.
1.01	7.30	30	.08	.05	.03	26.
1.01	7.45	31	.08	.05	.03	66.
1.01	8.00	32	.08	.05	.03	135.
1.01	8.15	33	.08	.05	.03	238.
1.01	8.30	34	.08	.05	.03	367.
1.01	8.45	35	.08	.05	.03	508.
1.01	9.00	36	.08	.05	.03	652.
1.01	9.15	37	.08	.05	.03	788.
1.01	9.30	38	.08	.05	.03	911.
1.01	9.45	39	.08	.05	.03	1018.
1.01	10.00	40	.08	.05	.03	1103.
1.01	10.15	41	.08	.05	.03	1170.
1.01	10.30	42	.08	.05	.03	1223.
1.01	10.45	43	.08	.05	.03	1265.
1.01	11.00	44	.08	.05	.03	1300.
1.01	11.15	45	.08	.05	.03	1328.
1.01	11.30	46	.08	.05	.03	1350.
1.01	11.45	47	.08	.05	.03	1368.
1.01	12.00	48	.08	.05	.03	1383.
1.01	12.15	49	.52	.50	.03	1459.
1.01	12.30	50	.52	.50	.03	1663.
1.01	12.45	51	.52	.50	.03	2048.
1.01	13.00	52	.52	.50	.03	2703.
1.01	13.15	53	.63	.60	.03	3654.
1.01	13.30	54	.63	.60	.03	4827.
1.01	13.45	55	.63	.60	.03	6116.
1.01	14.00	56	.63	.60	.03	7467.
1.01	14.15	57	.78	.76	.03	8826.
1.01	14.30	58	.78	.76	.03	10157.
1.01	14.45	59	.78	.76	.03	11423.
1.01	15.00	60	.78	.76	.03	12599.
1.01	15.15	61	.79	.77	.03	13711.
1.01	15.30	62	1.58	1.56	.03	14877.
1.01	15.45	63	4.44	4.41	.03	16607.
1.01	16.00	64	1.11	1.08	.03	18913.
1.01	16.15	65	.73	.70	.03	21748.
1.01	16.30	66	.73	.70	.03	25238.
1.01	19.00	76	.04	.02	.03	19971.
1.01	19.15	77	.04	.02	.03	17598.
1.01	19.30	78	.04	.02	.03	15252.
1.01	19.45	79	.04	.02	.03	12949.
1.01	20.00	80	.04	.02	.03	10792.
1.01	20.15	81	.04	.02	.03	8919.
1.01	20.30	82	.04	.02	.03	7282.
1.01	20.45	83	.04	.02	.03	5896.
1.01	21.00	84	.04	.02	.03	4810.
1.01	21.15	85	.04	.02	.03	3955.
1.01	21.30	86	.04	.02	.03	3271.
1.01	21.45	87	.04	.02	.03	2724.
1.01	22.00	88	.04	.02	.03	2275.
1.01	22.15	89	.04	.02	.03	1910.
1.01	22.30	90	.04	.02	.03	1623.
1.01	22.45	91	.04	.02	.03	1498.
1.01	23.00	92	.04	.02	.03	1398.
1.01	23.15	93	.04	.02	.03	1304.
1.01	23.30	94	.04	.02	.03	1217.
1.01	23.45	95	.04	.02	.03	1136.
1.02	0.00	96	.04	.02	.03	1060.
1.02	.15	97	0.00	0.00	0.00	989.
1.02	.30	98	0.00	0.00	0.00	922.
1.02	.45	99	0.00	0.00	0.00	861.
1.02	1.00	100	0.00	0.00	0.00	803.
1.02	1.15	101	0.00	0.00	0.00	749.
1.02	1.30	102	0.00	0.00	0.00	699.
1.02	1.45	103	0.00	0.00	0.00	652.
1.02	2.00	104	0.00	0.00	0.00	609.
1.02	2.15	105	0.00	0.00	0.00	568.
1.02	2.30	106	0.00	0.00	0.00	530.
1.02	2.45	107	0.00	0.00	0.00	494.
1.02	3.00	108	0.00	0.00	0.00	461.
1.02	3.15	109	0.00	0.00	0.00	430.
1.02	3.30	110	0.00	0.00	0.00	401.
1.02	3.45	111	0.00	0.00	0.00	375.
1.02	4.00	112	0.00	0.00	0.00	350.
1.02	4.15	113	0.00	0.00	0.00	326.
1.02	4.30	114	0.00	0.00	0.00	304.
1.02	4.45	115	0.00	0.00	0.00	284.
1.02	5.00	116	0.00	0.00	0.00	265.
1.02	5.15	117	0.00	0.00	0.00	247.
1.02	5.30	118	0.00	0.00	0.00	231.
1.02	5.45	119	0.00	0.00	0.00	215.
1.02	6.00	120	0.00	0.00	0.00	201.
1.02	6.15	121	0.00	0.00	0.00	187.
1.02	6.30	122	0.00	0.00	0.00	175.
1.02	6.45	123	0.00	0.00	0.00	163.
1.02	7.00	124	0.00	0.00	0.00	152.
1.02	7.15	125	0.00	0.00	0.00	142.
1.02	7.30	126	0.00	0.00	0.00	132.
1.02	7.45	127	0.00	0.00	0.00	124.
1.02	8.00	128	0.00	0.00	0.00	115.
1.02	8.15	129	0.00	0.00	0.00	108.
1.02	8.30	130	0.00	0.00	0.00	100.
1.02	8.45	131	0.00	0.00	0.00	94.
1.02	9.00	132	0.00	0.00	0.00	87.
1.02	9.15	133	0.00	0.00	0.00	82.
1.02	9.30	134	0.00	0.00	0.00	76.
1.02	9.45	135	0.00	0.00	0.00	71.
1.02	10.00	136	0.00	0.00	0.00	66.
1.02	10.15	137	0.00	0.00	0.00	62.
1.02	10.30	138	0.00	0.00	0.00	58.
1.02	10.45	139	0.00	0.00	0.00	54.
1.02	11.00	140	0.00	0.00	0.00	50.
1.02	11.15	141	0.00	0.00	0.00	47.

.01	18.45	67	.73	.70	.03	28587.	1.02	11.30	142	0.00	0.00	0.00	44.
.01	17.00	68	.73	.70	.03	30857.	1.02	11.45	143	0.00	0.00	0.00	41.
1.01	17.15	69	.57	.55	.03	31797.	1.02	12.00	144	0.00	0.00	0.00	38.
1.01	17.30	70	.57	.55	.03	31751.	1.02	12.15	145	0.00	0.00	0.00	35.
1.01	17.45	71	.57	.55	.03	30800.	1.02	12.30	146	0.00	0.00	0.00	33.
1.01	18.00	72	.57	.55	.03	29297.	1.02	12.45	147	0.00	0.00	0.00	31.
1.01	18.15	73	.04	.02	.03	27257.	1.02	13.00	148	0.00	0.00	0.00	29.
1.01	18.30	74	.04	.02	.03	24712.	1.02	13.15	149	0.00	0.00	0.00	27.
1.01	18.45	75	.04	.02	.03	22293.	1.02	13.30	150	0.00	0.00	0.00	25.
									SUM	24.39	21.69	2.69	598973.
										(619.)	(551.)	(68.)	(16961.03)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	31797.	20336.	6223.	3993.	598956.
CMS	900.	576.	176.	113.	16961.
INCHES		18.02	22.05	22.11	22.11
MM		457.61	560.10	561.59	561.59
AC-FT		10084.	12342.	12375.	12375.
THOUS CU M		12438.	15224.	15264.	15264.

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 .90	RATIO 2 .80	RATIO 3 .70	RATIO 4 .60	RATIO 5 .50	RATIO 6 .40	RATIO 7 .30	RATIO 8 .20	RATIO 9 .10
HYDROGRAPH AT	LAKE	10.50	1	28618.	25438.	22258.	19078.	15899.	12719.	9539.	6359.	3180.
		(27.19)		(810.36)	(720.32)	(630.28)	(540.24)	(450.20)	(360.16)	(270.12)	(180.08)	(90.04)
ROUTED TO	DAM	10.50	1	28623.	25443.	22263.	19083.	15902.	12721.	9539.	6354.	3156.
		(27.19)		(810.51)	(720.47)	(630.42)	(540.36)	(450.29)	(360.21)	(270.11)	(179.94)	(89.37)
ROUTED TO	2300	10.50	1	28626.	25434.	22254.	19077.	15894.	12721.	9538.	6351.	3148.
		(27.19)		(810.61)	(720.21)	(630.16)	(540.21)	(450.06)	(360.23)	(270.10)	(179.83)	(89.14)

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	147.30	140.00	147.30
STORAGE	163.	77.	163.
OUTFLOW	4620.	0.	4620.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.90	158.13	10.83	379.	28623.	7.50	17.50	0.00
.80	157.04	9.74	351.	25443.	7.00	17.50	0.00
.70	155.89	8.59	324.	22263.	6.75	17.50	0.00
.60	154.67	7.37	297.	19083.	6.50	17.50	0.00
.50	153.38	6.08	270.	15902.	5.75	17.50	0.00
.40	151.99	4.69	242.	12721.	5.25	17.50	0.00
.30	150.44	3.14	214.	9539.	3.75	17.50	0.00
.20	148.61	1.31	183.	6354.	2.25	17.50	0.00
.10	145.66	0.00	163.	4620.	0.00	0.00	0.00

PLAN 1 STATION 2300

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.90	28626.	99.9	17.50
.80	25434.	99.3	17.50
.70	22254.	98.6	17.50
.60	19077.	97.9	17.50
.50	15894.	97.0	17.50
.40	12721.	96.0	17.50
.30	9538.	94.6	17.50
.20	6351.	92.8	17.50
.10	3148.	90.4	17.50

```
**********
OOD HYDROGRAPH PACKAGE (HEC-1)
N SAFETY VERSION      JULY 1978
LAST MODIFICATION  26 FEB 79
**********
```

```
 1              A1       N.J. DAM INSPECTION
 2              A2       EAST BRANCH RES.
 3              A3       ~~MULTY RATIO PMF ROUTING~~ DAM BREAK ANALYSIS
 4              B    150       0       15        0        0        0        0        0        0        0
 5              B1     5
 6              J      1       1        1
 7              J1    .5
 8              K      0    LAKE                                                  1
 9              K1       INFLOW HYDROGRAPH TO EAST BRANCH RESERVOIR
10              M      1       2     10.5             10.5                                      1
11              P      0      26      100      109      117
12              T                                                                1       .1
13              M2           1.74
14              X     -1   -0.05        2
15              K      1     DAM                                                 1
16              K1       ROUTING THROUGH RES.
17              Y                                 1        1
18              Y1     1                                                -147.3
19              SA     0     9.2    27.6
20              SE   115     140     160
21              SS   140    62.8    3.73      1.5
22              SD 147.3    3.73     1.5     79.2
23              SB    50       0      132        1      140      150
24              K      1    2300                                                 1
25              K1       ROUTE HYDROGRAPH TO REACH I(2300 FT D/S)
26              Y                                 1        1
27              Y1     1                                                      -1
28              Y6   .07     .04     .07       85      120     2300     .0117
29              Y7   500     120     620      100      800       95      830       85      870       85
30              Y7   900      95    1130      100     1280      120
31              K     99
```

PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

```
RUNOFF HYDROGRAPH AT        LAKE
ROUTE HYDROGRAPH TO          DAM
ROUTE HYDROGRAPH TO         2300
END OF NETWORK
```

RUN DATE 79/07/10.
TIME 16.10.54.

N.J. DAM INSPECTION
EAST BRANCH RES.
~~MULTY RATIO PMF ROUTING~~ DAM BREAK ANALYSIS

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
150	0	15	0	0	0	0	0	0	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 1 LRTIO= 1
RTIOS= .50

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH TO EAST BRANCH RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
LAKE	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	10.50	0.00	10.50	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	26.00	100.00	109.00	117.00	0.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .802

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.10	0.00	0.00

UNIT HYDROGRAPH DATA
TC= 0.00 LAG= 1.74

RECESSION DATA
STRTQ= -1.00 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 37 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= 1.74 VOL= 1.00

146.	439.	852.	1465.	2101.	2536.	2703.	2700.	2517.	2251.
1919.	1500.	1170.	936.	751.	618.	499.	393.	320.	258.
205.	165.	133.	106.	86.	70.	56.	45.	36.	29.
25.	20.	16.	12.	8.	5.	1.			

0
END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q

1.01	.30	2	.03	0.00	.03	9.
1.01	.45	3	.03	0.00	.03	9.
1.01	1.00	4	.03	0.00	.03	8.
1.01	1.15	5	.03	0.00	.03	7.
1.01	1.30	6	.03	0.00	.03	7.
1.01	1.45	7	.03	0.00	.03	6.
1.01	2.00	8	.03	0.00	.03	6.
1.01	2.15	9	.03	0.00	.03	6.
1.01	2.30	10	.03	0.00	.03	5.
1.01	2.45	11	.03	0.00	.03	5.
1.01	3.00	12	.03	0.00	.03	5.
1.01	3.15	13	.03	0.00	.03	4.
1.01	3.30	14	.03	0.00	.03	4.
1.01	3.45	15	.03	0.00	.03	4.
1.01	4.00	16	.03	0.00	.03	3.
1.01	4.15	17	.03	0.00	.03	3.
1.01	4.30	18	.03	0.00	.03	3.
1.01	4.45	19	.03	0.00	.03	3.
1.01	5.00	20	.03	0.00	.03	3.
1.01	5.15	21	.03	0.00	.03	2.
1.01	5.30	22	.03	0.00	.03	2.
1.01	5.45	23	.03	0.00	.03	2.
1.01	6.00	24	.03	0.00	.03	2.
1.01	6.15	25	.08	0.00	.08	2.
1.01	6.30	26	.08	0.00	.08	2.
1.01	6.45	27	.08	0.00	.08	2.
1.01	7.00	28	.08	0.00	.08	2.
1.01	7.15	29	.08	.04	.04	7.
1.01	7.30	30	.08	.05	.03	26.
1.01	7.45	31	.08	.05	.03	66.
1.01	8.00	32	.08	.05	.03	135.
1.01	8.15	33	.08	.05	.03	238.
1.01	8.30	34	.08	.05	.03	367.
1.01	8.45	35	.08	.05	.03	508.
1.01	9.00	36	.08	.05	.03	652.
1.01	9.15	37	.08	.05	.03	788.
1.01	9.30	38	.08	.05	.03	911.
1.01	9.45	39	.08	.05	.03	1018.
1.01	10.00	40	.08	.05	.03	1103.
1.01	10.15	41	.08	.05	.03	1170.
1.01	10.30	42	.08	.05	.03	1223.
1.01	10.45	43	.08	.05	.03	1265.
1.01	11.00	44	.08	.05	.03	1300.
1.01	11.15	45	.08	.05	.03	1328.
1.01	11.30	46	.08	.05	.03	1350.
1.01	11.45	47	.08	.05	.03	1368.
1.01	12.00	48	.08	.05	.03	1383.
1.01	12.15	49	.52	.50	.03	1459.
1.01	12.30	50	.52	.50	.03	1663.
1.01	12.45	51	.52	.50	.03	2048.
1.01	13.00	52	.52	.50	.03	2703.
1.01	13.15	53	.63	.60	.03	3654.
1.01	13.30	54	.63	.60	.03	4827.
1.01	13.45	55	.63	.60	.03	6116.
1.01	14.00	56	.63	.60	.03	7467.
1.01	14.15	57	.78	.76	.03	8826.
1.01	14.30	58	.78	.76	.03	10157.
1.01	14.45	59	.78	.76	.03	11423.
1.01	15.00	60	.78	.76	.03	12599.
1.01	15.15	61	.79	.77	.03	13711.
1.01	15.30	62	1.58	1.56	.03	14877.
1.01	15.45	63	4.44	4.41	.03	16607.
1.01	16.00	64	1.11	1.08	.03	18913.
1.01	16.15	65	.73	.70	.03	21748.
1.01	16.30	66	.73	.70	.03	25238.
1.01	19.15	77	.04	.02	.03	17598.
1.01	19.30	78	.04	.02	.03	15252.
1.01	19.45	79	.04	.02	.03	12949.
1.01	20.00	80	.04	.02	.03	10792.
1.01	20.15	81	.04	.02	.03	8919.
1.01	20.30	82	.04	.02	.03	7282.
1.01	20.45	83	.04	.02	.03	5896.
1.01	21.00	84	.04	.02	.03	4810.
1.01	21.15	85	.04	.02	.03	3955.
1.01	21.30	86	.04	.02	.03	3271.
1.01	21.45	87	.04	.02	.03	2724.
1.01	22.00	88	.04	.02	.03	2275.
1.01	22.15	89	.04	.02	.03	1910.
1.01	22.30	90	.04	.02	.03	1623.
1.01	22.45	91	.04	.02	.03	1490.
1.01	23.00	92	.04	.02	.03	1398.
1.01	23.15	93	.04	.02	.03	1304.
1.01	23.30	94	.04	.02	.03	1217.
1.01	23.45	95	.04	.02	.03	1136.
1.02	0.00	96	.04	.02	.03	1060.
1.02	.15	97	0.00	0.00	0.00	989.
1.02	.30	98	0.00	0.00	0.00	922.
1.02	.45	99	0.00	0.00	0.00	861.
1.02	1.00	100	0.00	0.00	0.00	803.
1.02	1.15	101	0.00	0.00	0.00	749.
1.02	1.30	102	0.00	0.00	0.00	699.
1.02	1.45	103	0.00	0.00	0.00	652.
1.02	2.00	104	0.00	0.00	0.00	609.
1.02	2.15	105	0.00	0.00	0.00	568.
1.02	2.30	106	0.00	0.00	0.00	530.
1.02	2.45	107	0.00	0.00	0.00	494.
1.02	3.00	108	0.00	0.00	0.00	461.
1.02	3.15	109	0.00	0.00	0.00	430.
1.02	3.30	110	0.00	0.00	0.00	401.
1.02	3.45	111	0.00	0.00	0.00	375.
1.02	4.00	112	0.00	0.00	0.00	350.
1.02	4.15	113	0.00	0.00	0.00	326.
1.02	4.30	114	0.00	0.00	0.00	304.
1.02	4.45	115	0.00	0.00	0.00	284.
1.02	5.00	116	0.00	0.00	0.00	265.
1.02	5.15	117	0.00	0.00	0.00	247.
1.02	5.30	118	0.00	0.00	0.00	231.
1.02	5.45	119	0.00	0.00	0.00	215.
1.02	6.00	120	0.00	0.00	0.00	201.
1.02	6.15	121	0.00	0.00	0.00	187.
1.02	6.30	122	0.00	0.00	0.00	175.
1.02	6.45	123	0.00	0.00	0.00	163.
1.02	7.00	124	0.00	0.00	0.00	152.
1.02	7.15	125	0.00	0.00	0.00	142.
1.02	7.30	126	0.00	0.00	0.00	132.
1.02	7.45	127	0.00	0.00	0.00	124.
1.02	8.00	128	0.00	0.00	0.00	115.
1.02	8.15	129	0.00	0.00	0.00	108.
1.02	8.30	130	0.00	0.00	0.00	100.
1.02	8.45	131	0.00	0.00	0.00	94.
1.02	9.00	132	0.00	0.00	0.00	87.
1.02	9.15	133	0.00	0.00	0.00	82.
1.02	9.30	134	0.00	0.00	0.00	76.
1.02	9.45	135	0.00	0.00	0.00	71.
1.02	10.00	136	0.00	0.00	0.00	66.
1.02	10.15	137	0.00	0.00	0.00	62.
1.02	10.30	138	0.00	0.00	0.00	58.
1.02	10.45	139	0.00	0.00	0.00	54.
1.02	11.00	140	0.00	0.00	0.00	50.
1.02	11.15	141	0.00	0.00	0.00	47.

1.01	16.45	67	.73	.70	.03	28587.	1.02	11.30	142	0.00	0.00	0.00	44.
1.01	17.00	68	.73	.70	.03	30857.	1.02	11.45	143	0.00	0.00	0.00	41.
1.01	17.15	69	.57	.55	.03	31797.	1.02	12.00	144	0.00	0.00	0.00	38.
1.01	17.30	70	.57	.55	.03	31751.	1.02	12.15	145	0.00	0.00	0.00	35.
1.01	17.45	71	.57	.55	.03	30800.	1.02	12.30	146	0.00	0.00	0.00	33.
1.01	18.00	72	.57	.55	.03	29297.	1.02	12.45	147	0.00	0.00	0.00	31.
1.01	18.15	73	.04	.02	.03	27257.	1.02	13.00	148	0.00	0.00	0.00	29.
1.01	18.30	74	.04	.02	.03	24712.	1.02	13.15	149	0.00	0.00	0.00	27.
1.01	18.45	75	.04	.02	.03	22293.	1.02	13.30	150	0.00	0.00	0.00	25.
									SUM	24.39	21.69	2.69	598973.
										(619.)	(551.)	(68.)	(16961.03)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	31797.	20336.	6223.	3993.	598956.
CMS	900.	576.	176.	113.	16961.
INCHES		18.02	22.05	22.11	22.11
MM		457.61	560.10	561.59	561.59
AC-FT		10084.	12342.	12375.	12375.
THOUS CU M		12438.	15224.	15264.	15264.

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIO APPLIED TO FLOWS 1 .50
HYDROGRAPH AT	LAKE	10.50 (27.19)	1	15899. (450.20)(
ROUTED TO	DAM	10.50 (27.19)	1	16157. (457.52)(
ROUTED TO	2300	10.50 (27.19)	1	15984. (452.62)(

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	140.00	140.00	147.30
STORAGE	77.	77.	163.
OUTFLOW	0.	0.	4620.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.50	150.13	2.83	209.	16157.	3.75	17.00	16.00

PLAN 1 STATION 2300

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.50	15984.	97.0	17.25

APPENDIX E

STABILITY CALCULATIONS

FREDERIC R. HARRIS, INC.
CONSULTING ENGINEERS

STATIC STABILITY.

COMPUTED BY HK CHECKED BY

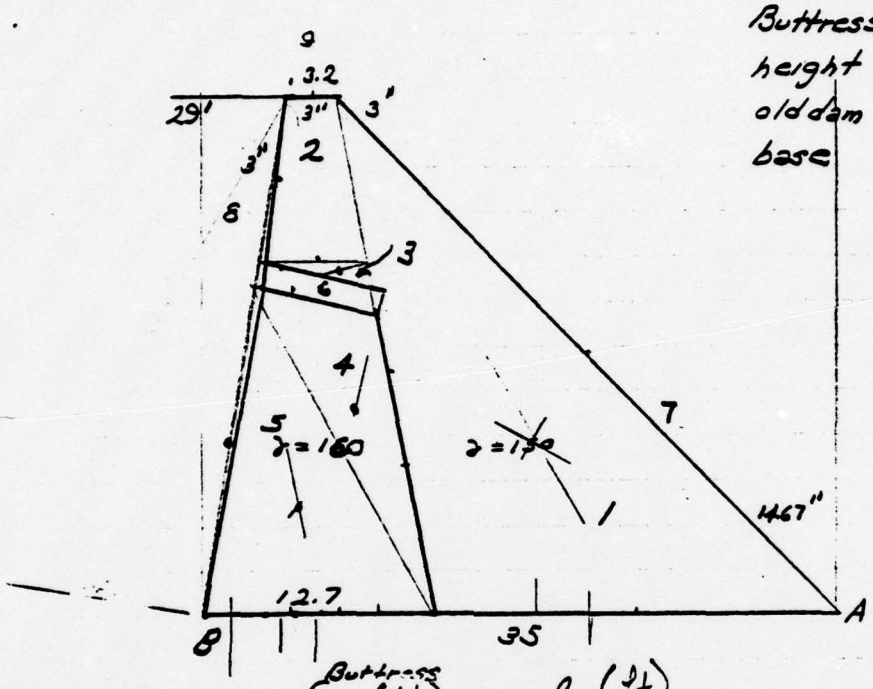
JOB NO. 10A20.01

DATE May 17, 1979

DETERMINATION of
RIGHTING MOMENT.

Scale 1"-10' used for conversion

Buttress 5		measured
height	29'	36.5
old dam	18.4	23.2
base	35	44.1
	4.8	6
	3.2	4
	12.7	16
	7.15	9
	9.5	12
	16.5	20.8



	Buttress	(Lb.)	ℓ (ft)	(ft-lb)
1	$\frac{22.2}{2} \times 29 \times 150 \times 2$	96,570	16.5	1,593,405
2	$\frac{3.2+5.8}{2} \times 9.1 \times 150 \times 2$	12,285	28.5	350,123
3	$\frac{6}{2} \times 1.5 \times 150 \times 2$	1350	27.5	37,125
4	$\frac{21}{2} \times 5 \times 160 \times 11$	92,400	26.5	2,448,600
5	$\frac{12.7}{2} \times 16.5 \times 160 \times 11$	206,756	29.8	6,161,329
6	$7 \times 1.2 \times 160 \times 11$	14,784	28.7	424,301
7	$\frac{1.22+.25}{2} \times 40 \times 150 \times 9$	39690	14	555,660
8	$.25 \times 9.5 \times 150 \times 9$	3206	31	99,394
9	$.25 \times 32 \times 150 \times 9$	1080	29	31,320
		468121		11,701,257

$$\bar{x} = \frac{11,701,257}{468121} = 25'$$

FREDERIC R. HARRIS, INC.
CONSULTING ENGINEERS

SUBJECT East Branch — SHEET NO. 2 OF 3
JOB NO.
COMPUTED BY H.K. CHECKED BY — DATE April 17, 1979

Overturning

		MOMENT (ft-lb)
Water pressure (TOP OF DAM).		
$\frac{1}{2} \times 29^2 \times 62.4 = 26,239.2 \times 11$	$\frac{29}{3}$	2,790,102
Uplift (questionable how this is applied)		
$\frac{29 \times 62.4 + 0}{2} \times 12.7 \times 11 = 126429$	$\frac{12.7}{3}$	535,214
Soil Pressure (unknown) Assume 10'		
$\frac{1}{2} \gamma H^2 K_a$		
$\frac{1}{2} \times 10^2 \times 60 \times \frac{1}{3} \times 11 = 11,000$	$\frac{10}{3}$	36,667
		3,361,983

Righting

466,121	10	4,661,210

Vertical

288631	$\frac{2 \times 29}{3}$	5580203

F.O.S. AGAINST
Overturning: $= \frac{10,241,913}{3,361,983} = \underline{\underline{3.05}}$

F.O.S. AGAINST
Sliding: $\frac{466121 + 288631 - 126429 \times .7}{288,631 + 11,000} = \underline{\underline{1.47}}$

Flood Level 6' head above top of dam.

			Moment (ft-lb)
Overturning Water pressure			
$6 \times 62.4 \times 29 \times 11 = 119,434$		$\frac{29}{2}$	1,731,651
$\frac{1}{2} \times 29^2 \times 62.4 \times 11 = 288631$		$\frac{29}{3}$	2,790,102
Uplift			
$\frac{35 \times 62.4 + 0}{2} \times 12.7 \times 11 = 152,552$		$\frac{12.7}{3}$	645805
Soil Pressure			
$\frac{1}{2} \times 10^2 \times 60 \times \frac{1}{3} \times 11 = 11,000$		$\frac{10}{3}$	36,667
			5,204,425
Righting			
466,121		10	4,661210
Vertical			
288631	288,631	$\frac{2 \times 29}{3}$	5580203
$6 \times 29 \times 62.4 \times 11 = 119,434$		$\frac{29}{2}$	1,731,793
			9,043,789

F.O.S. AGAINST
Overturning: $\frac{9,043,789}{5,204,425} = \underline{\underline{1.74}}$

F.O.S. AGAINST
Sliding: $\frac{466121 + 288631 + 119,434 - 152,552}{288,631 + 11,000} = 2.4$